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EPA Alkali Scrubbing Test Facility Advanced Program, Fourth Progress Report; Volume 2. Appendices

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16. ABSTRACT
The report gives results of advanced testing (late-November 1976 - June 1978) of 30,000-35,000 acfm (10 MW equivalent) lime/limestone wet scrubbers for SO2 and particulate removal at TVA's Shawnee power station. Forced oxidation with two scrubber loops was developed on the venturi/spray tower system with limestone, lime, and limestone/MgO slurries. Bleed stream oxidation was successful only with limestone/MgO slurry. Forced oxidation with a single scrubber loop was developed on the TCA system with limestone slurry. Other test blocks on the TCA were limestone with low fly ash loadings, limestone type and grind, automatic limestone feed control, limestone reliability, limestone with Ceilcote egg-crate type packing, lime/MgO, and flue characterization.

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Flue Gases	Aerosols	Stationary Sources	21B	07D
Scrubbers	Magnesium Oxides	Particulate	07A, 13I	
Tests			14B	
Calcium Oxides			07B	
Calcium Carbonates				
Sulfur Oxides				

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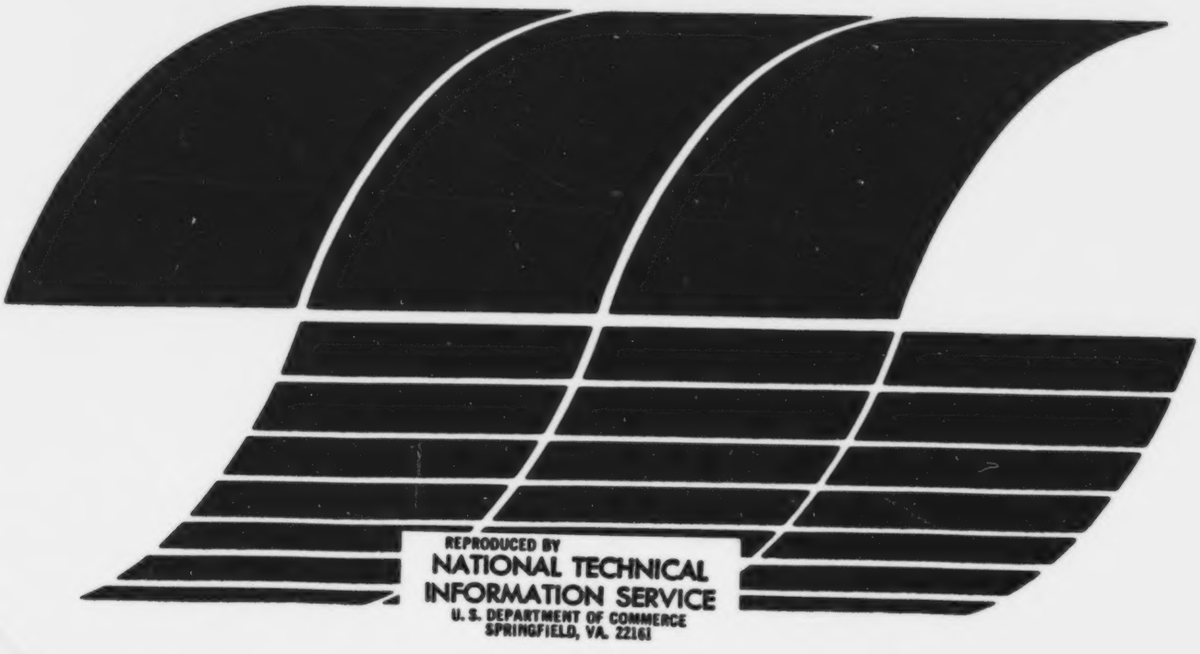

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by

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APPENDIX A

CONVERTING UNITS OF MEASURE

Appendix A

CONVERTING UNITS OF MEASURE

Environmental Protection Agency policy is to express all measurements in Agency documents in metric units. In this report, however, to avoid undue costs or lack of clarity, English units are used throughout. Conversion factors from English to metric units are given below:

To Convert From	To	Multiply By
scfm (60°F)	nm3/hr (0°C)	1.61
cfm	m3/hr	1.70
°F	°C	(°F-32)/1.8
ft	m	0.305
ft/hr	m/hr	0.305
ft/sec	m/sec	0.305
ft^2	m^2	0.0929
ft^2/tons per day	m^2/metric tons per day	0.102
gal/mcf	l/m^3	0.134
gpm	l/min	3.79
gpm/ft^2	$l/min/m^2$	40.8
gr/scf	gm/m^3	2.29
in.	cm	2.54
in. H_2O	mm Hg	1.87
lb	gm	454
lb-moles	gm-moles	454
lb-moles/hr	gm-moles/min	7.56
lb-moles/hr ft^2	gm-moles/min/m^2	81.4
lb-moles/min	gm-moles/sec	7.56
psia	kilopascal	6.895

APPENDIX B

SCRUBBER OPERATING PERIODS

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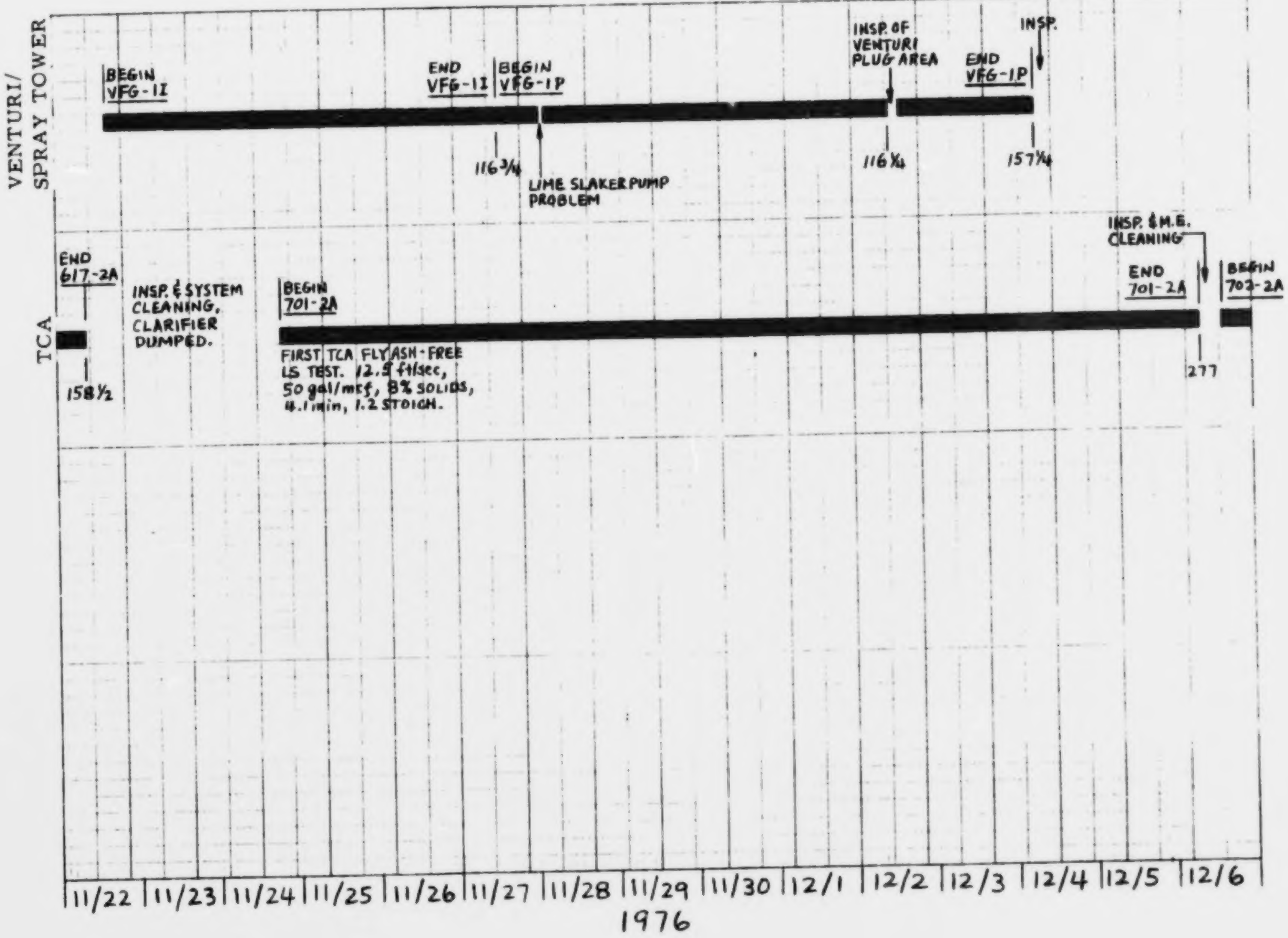

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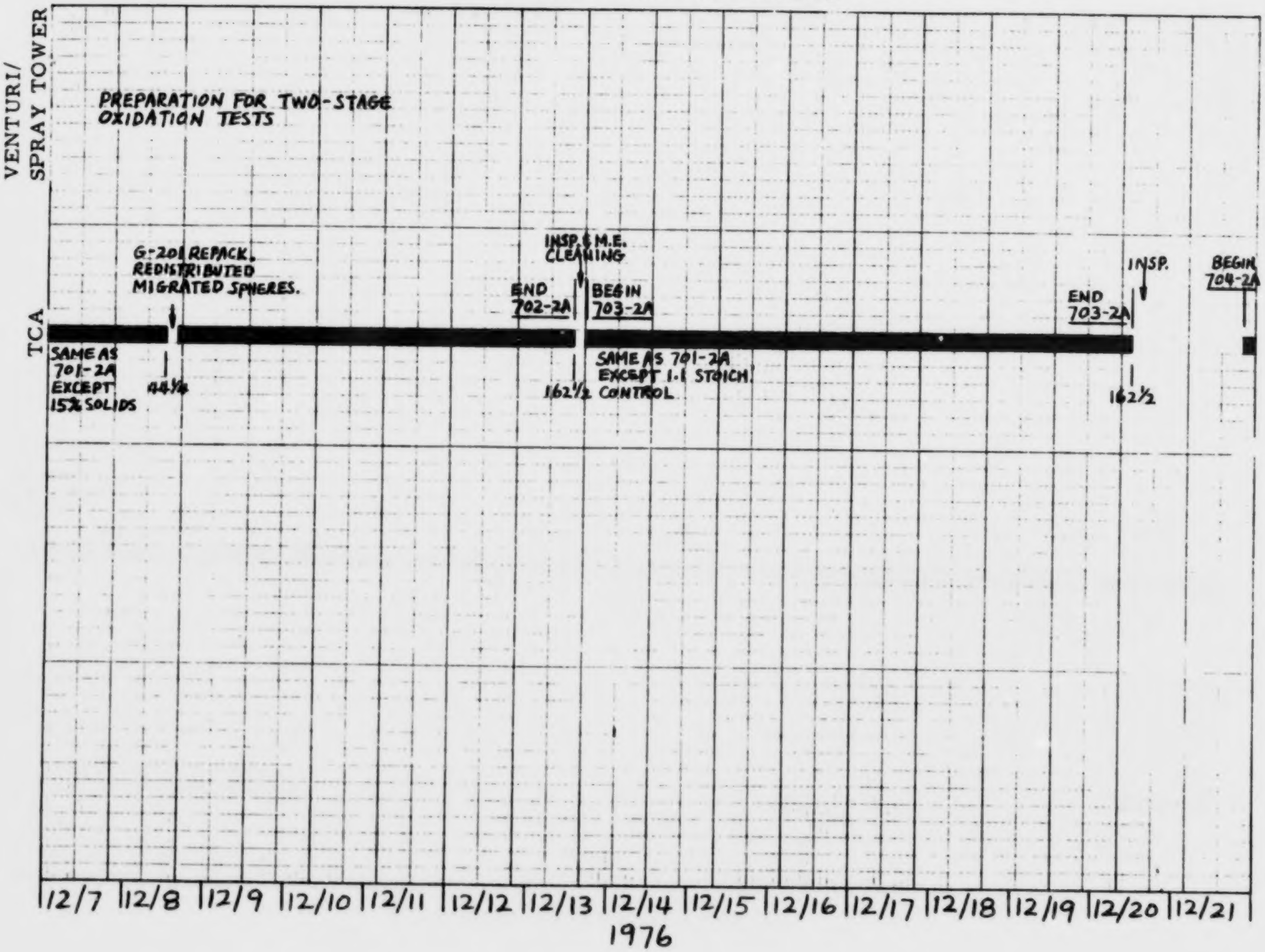

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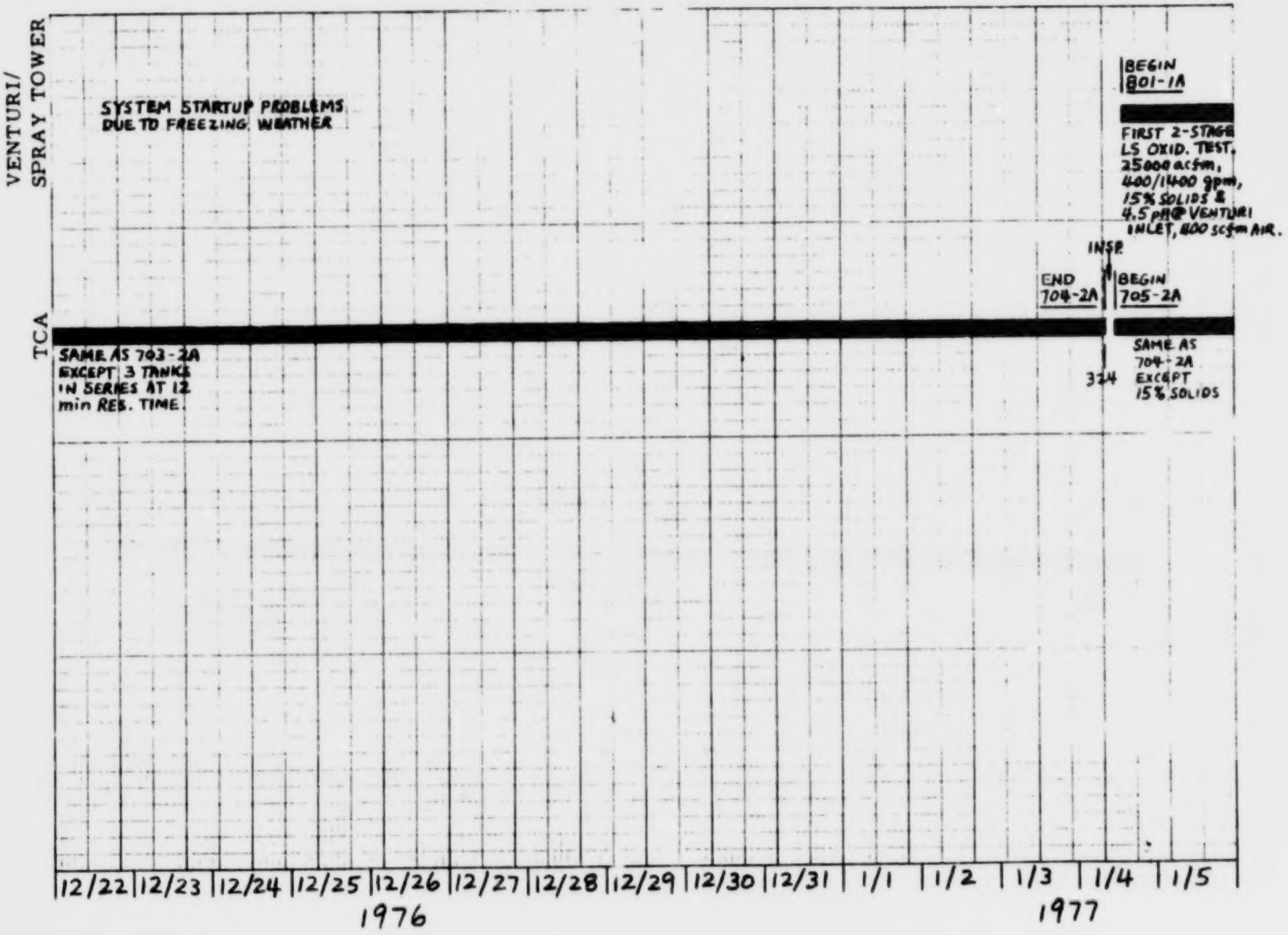

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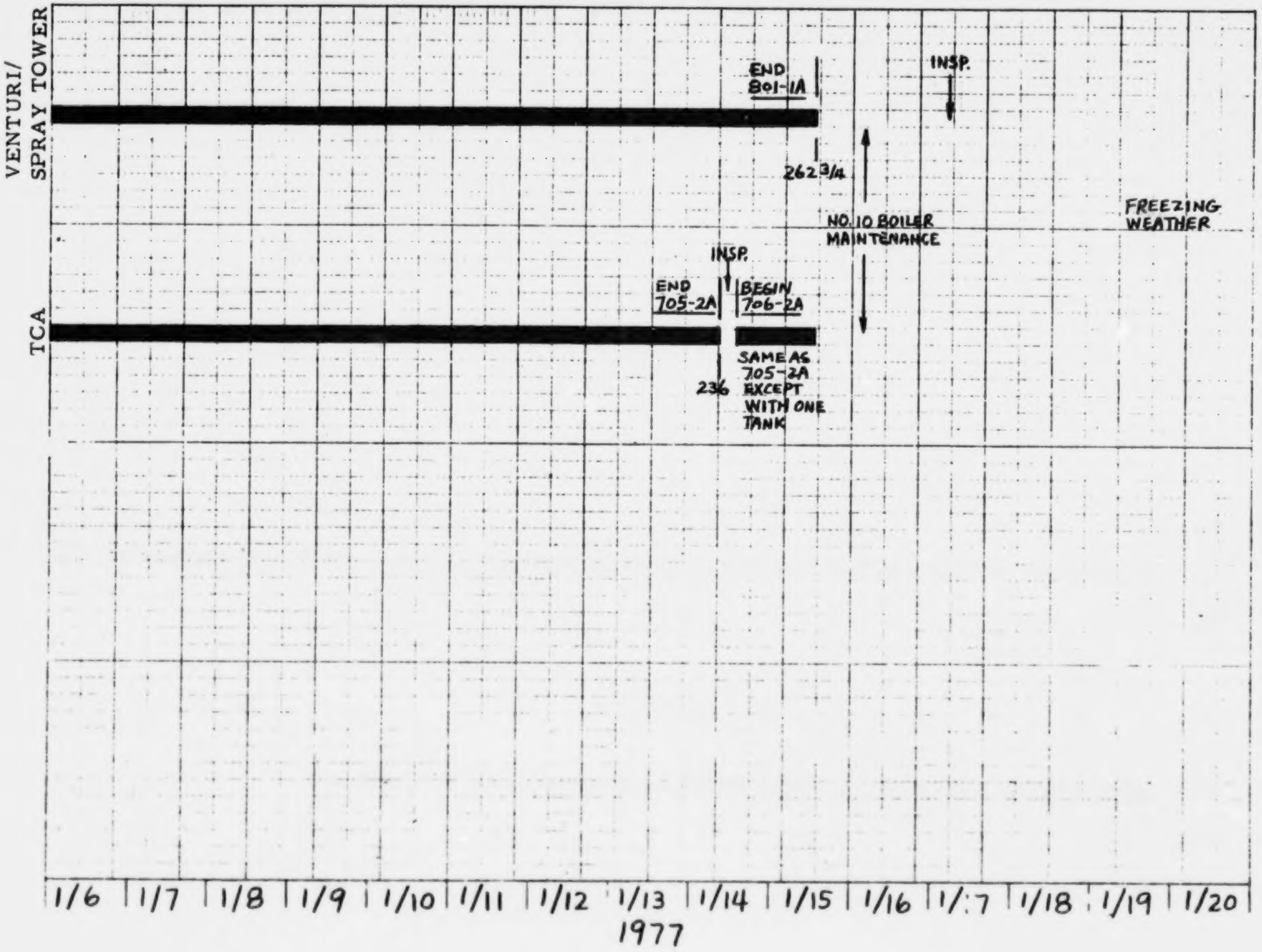

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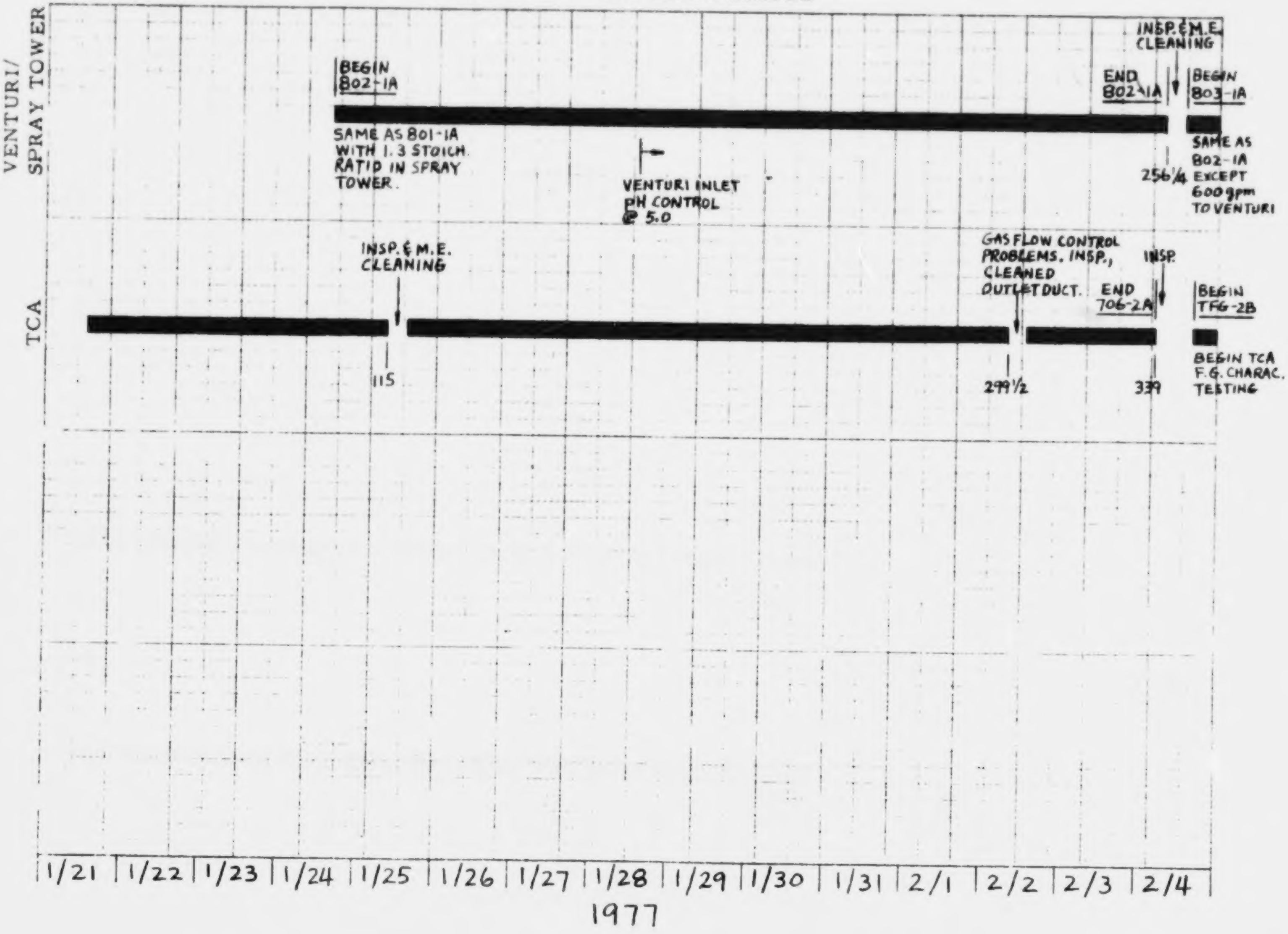

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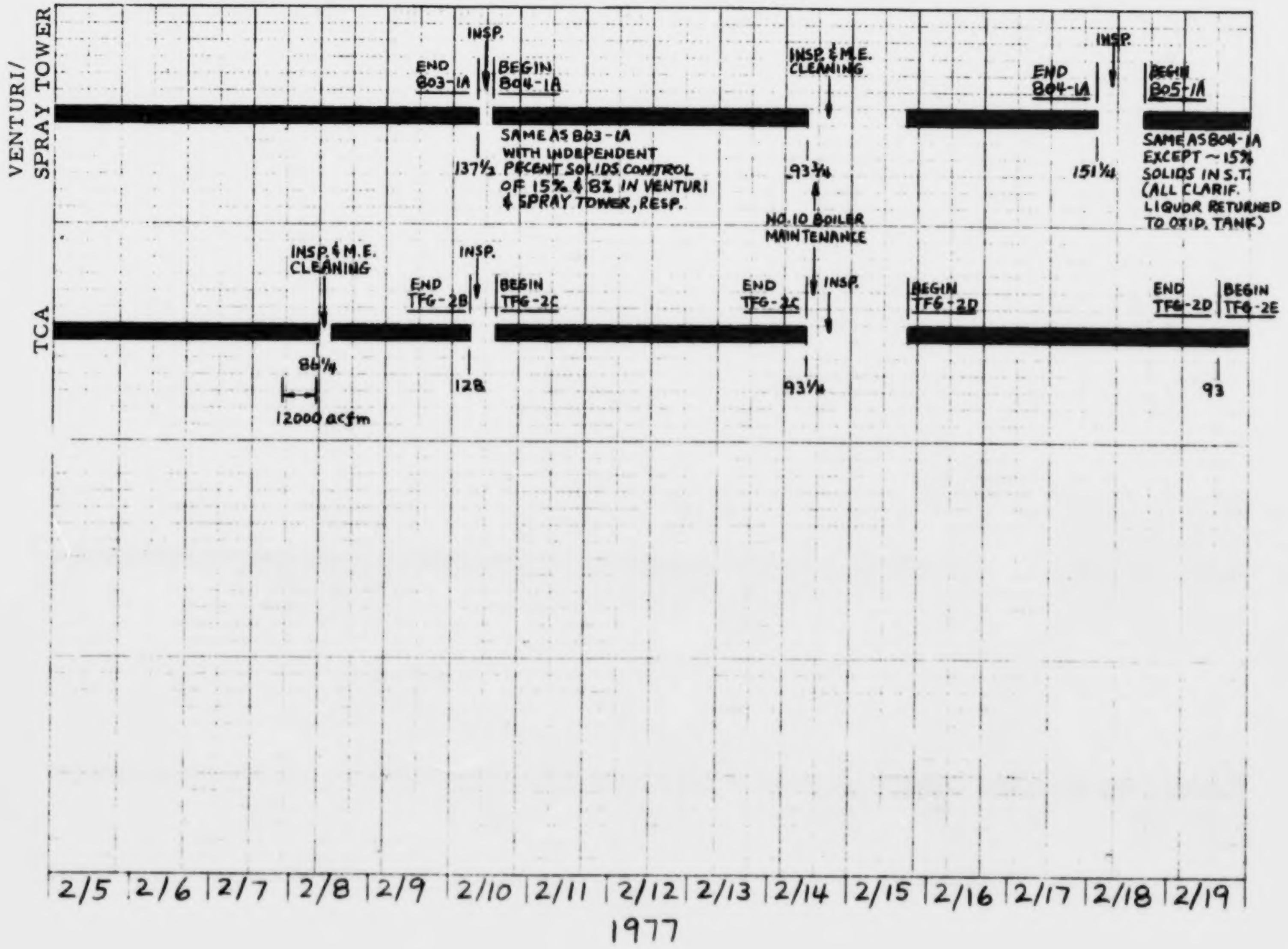

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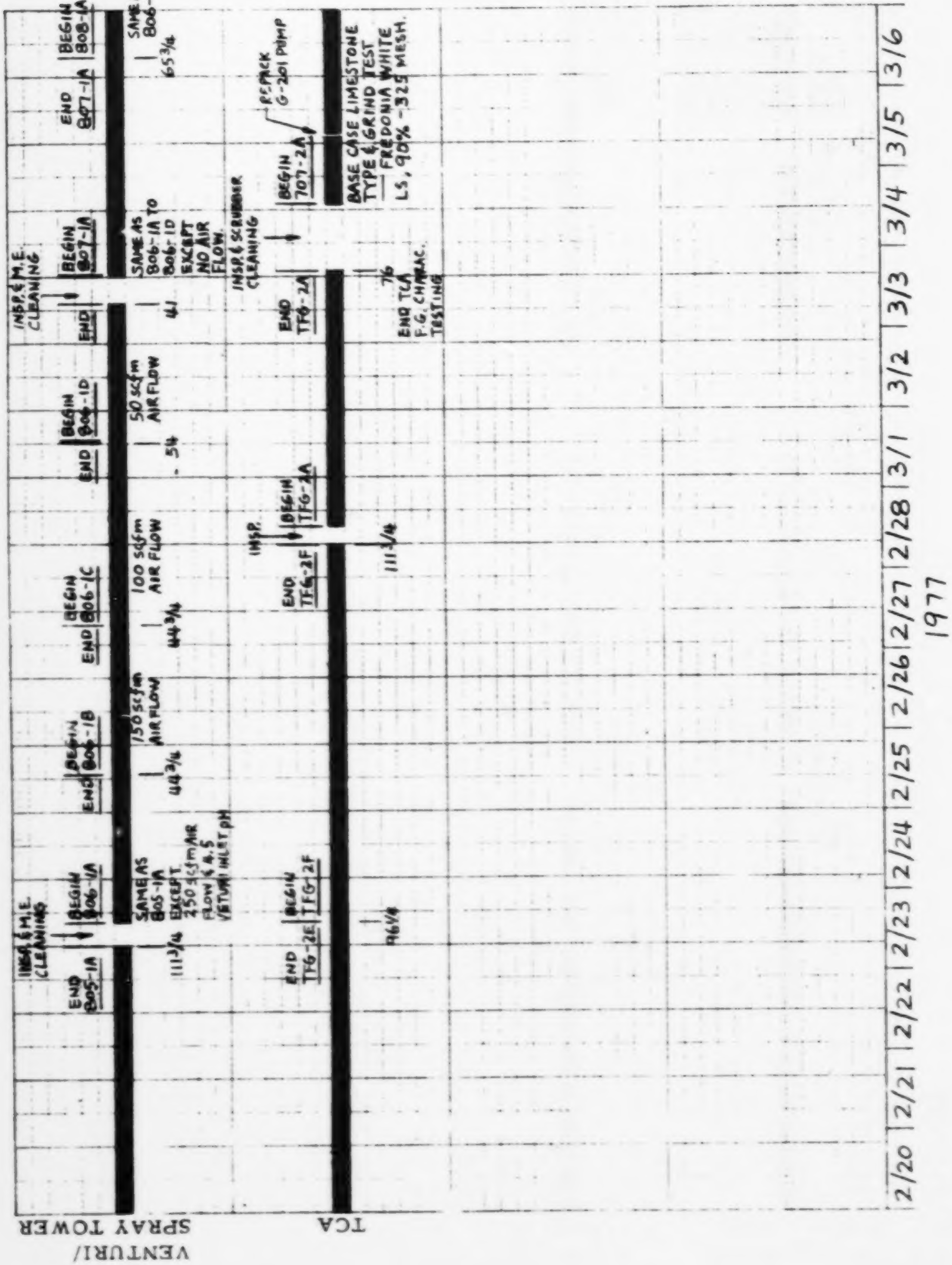

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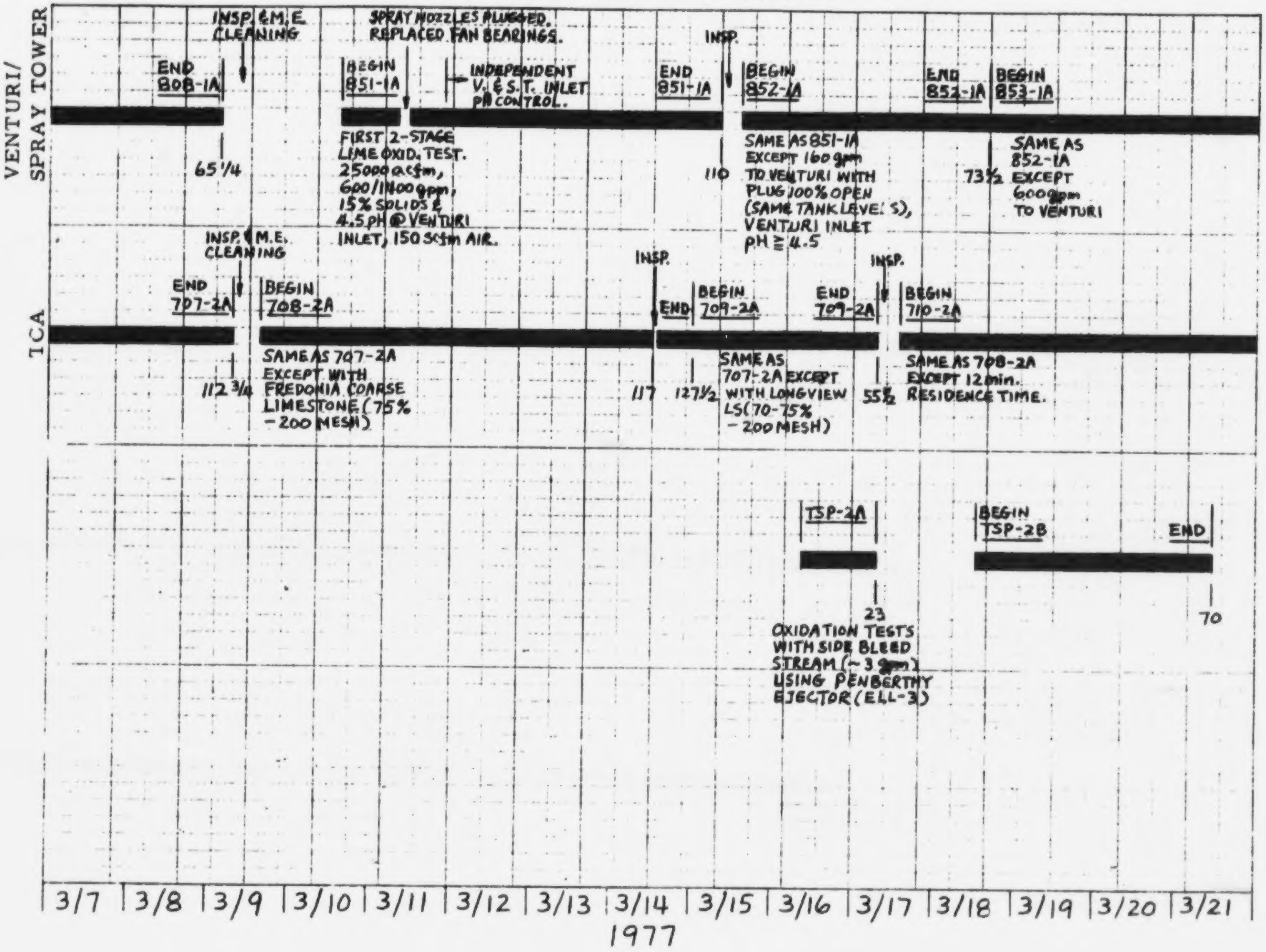

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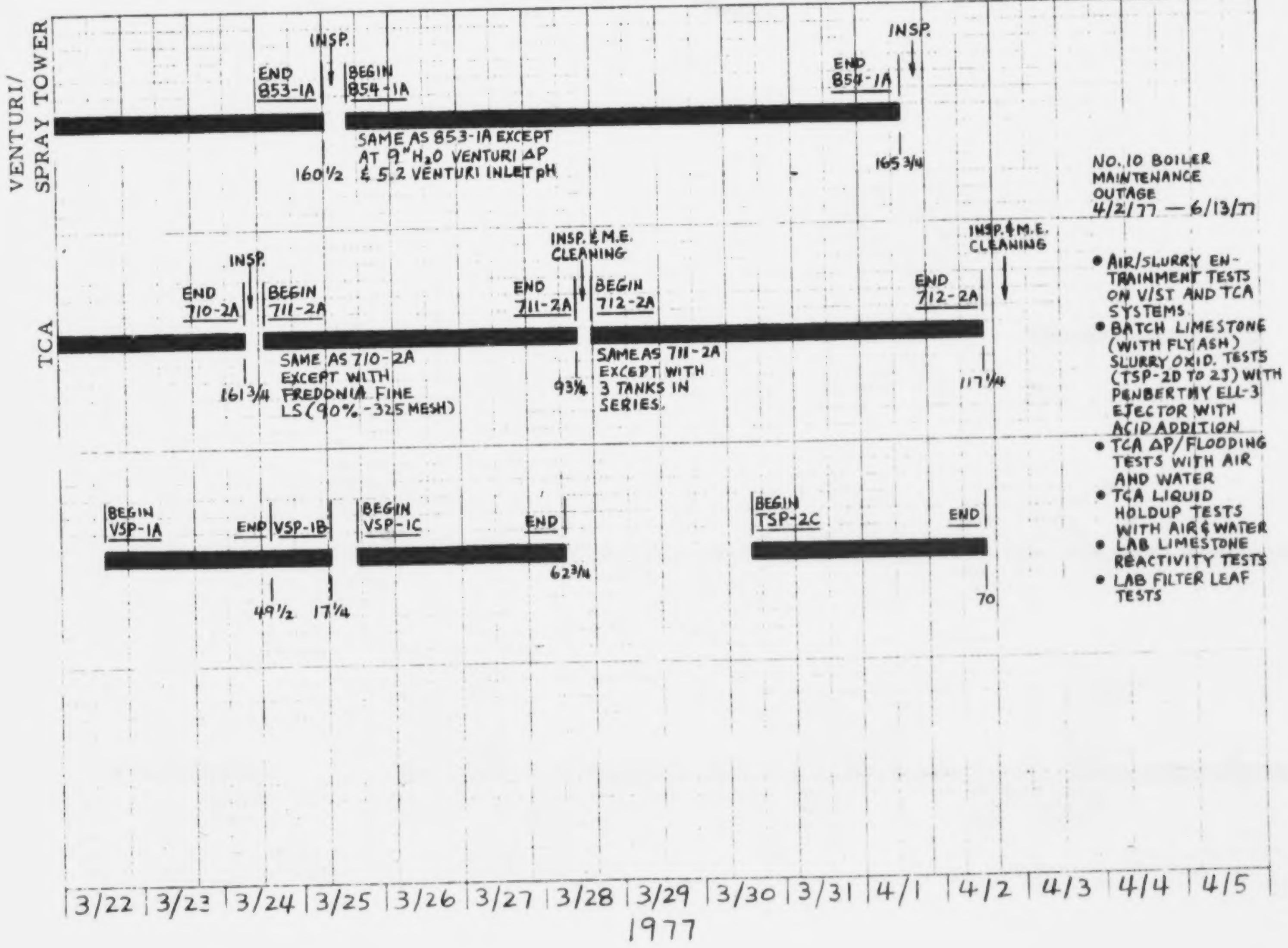

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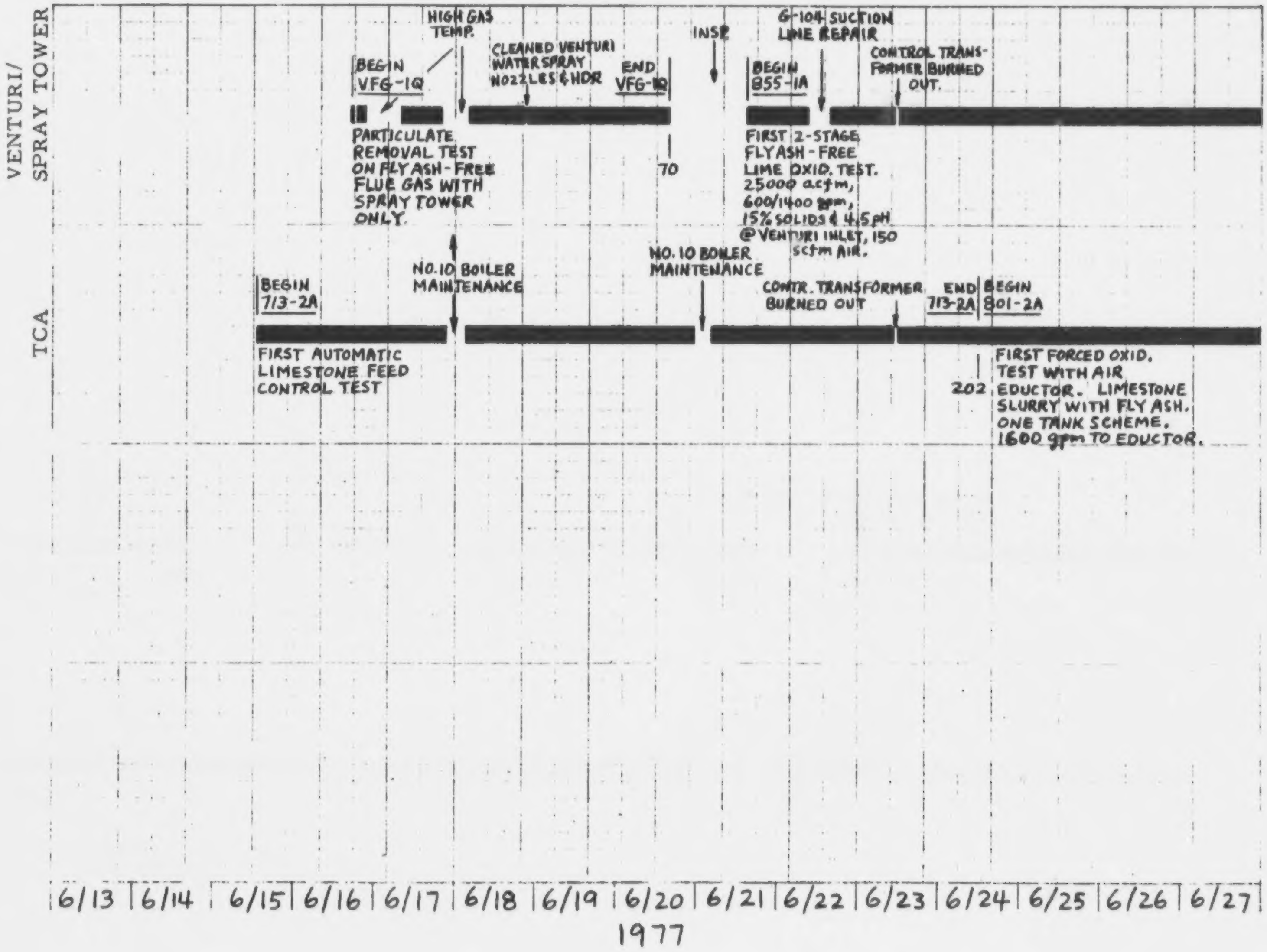

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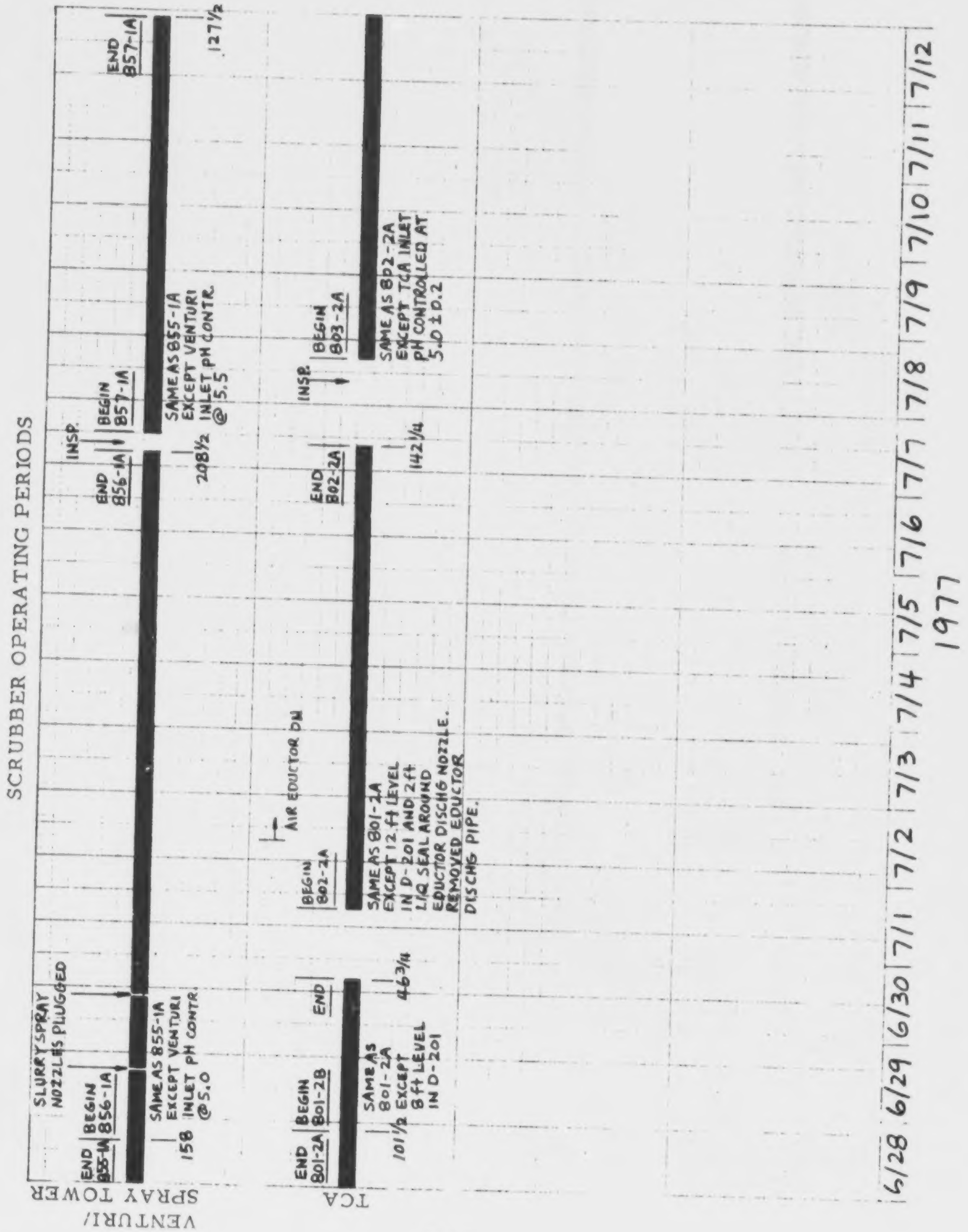

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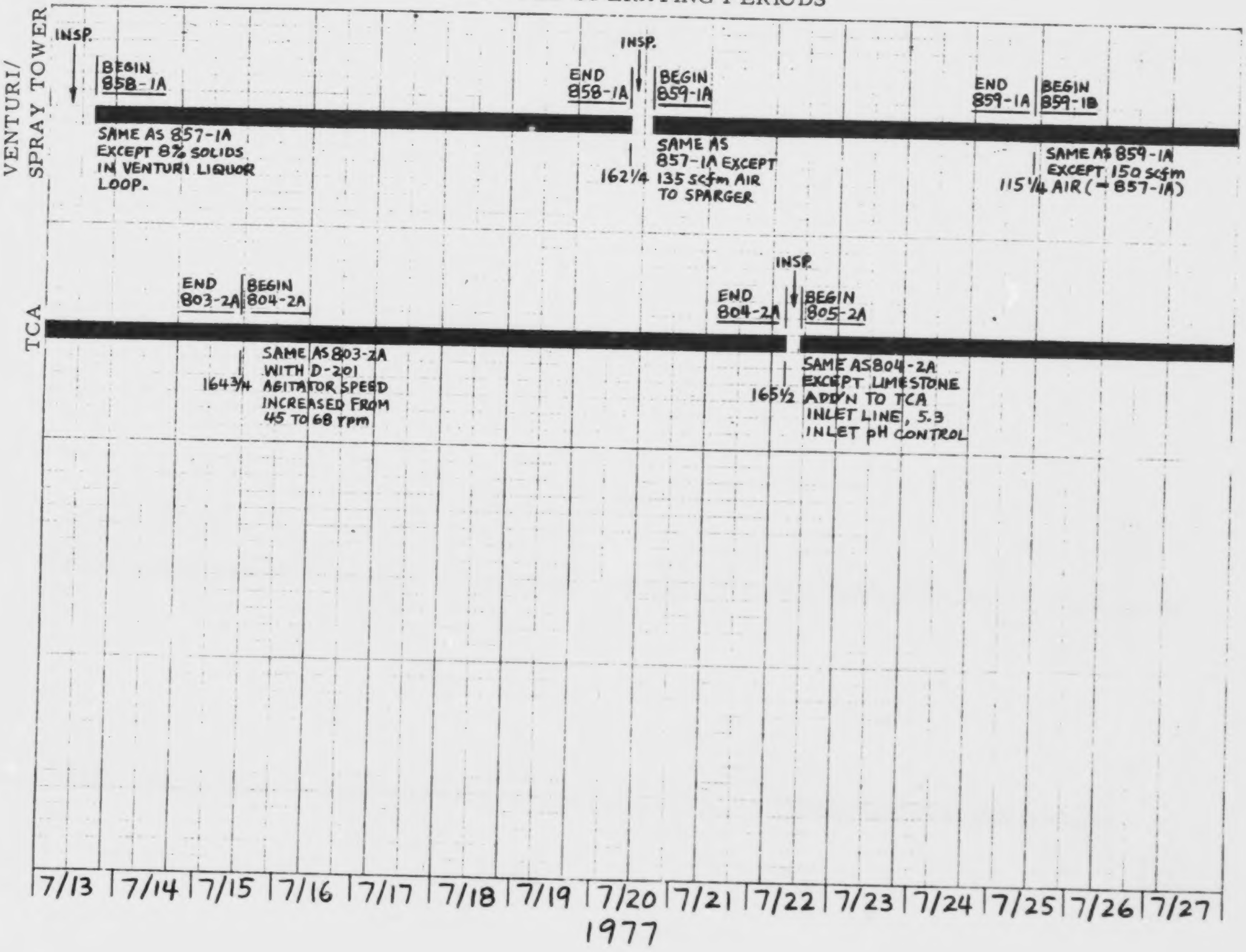

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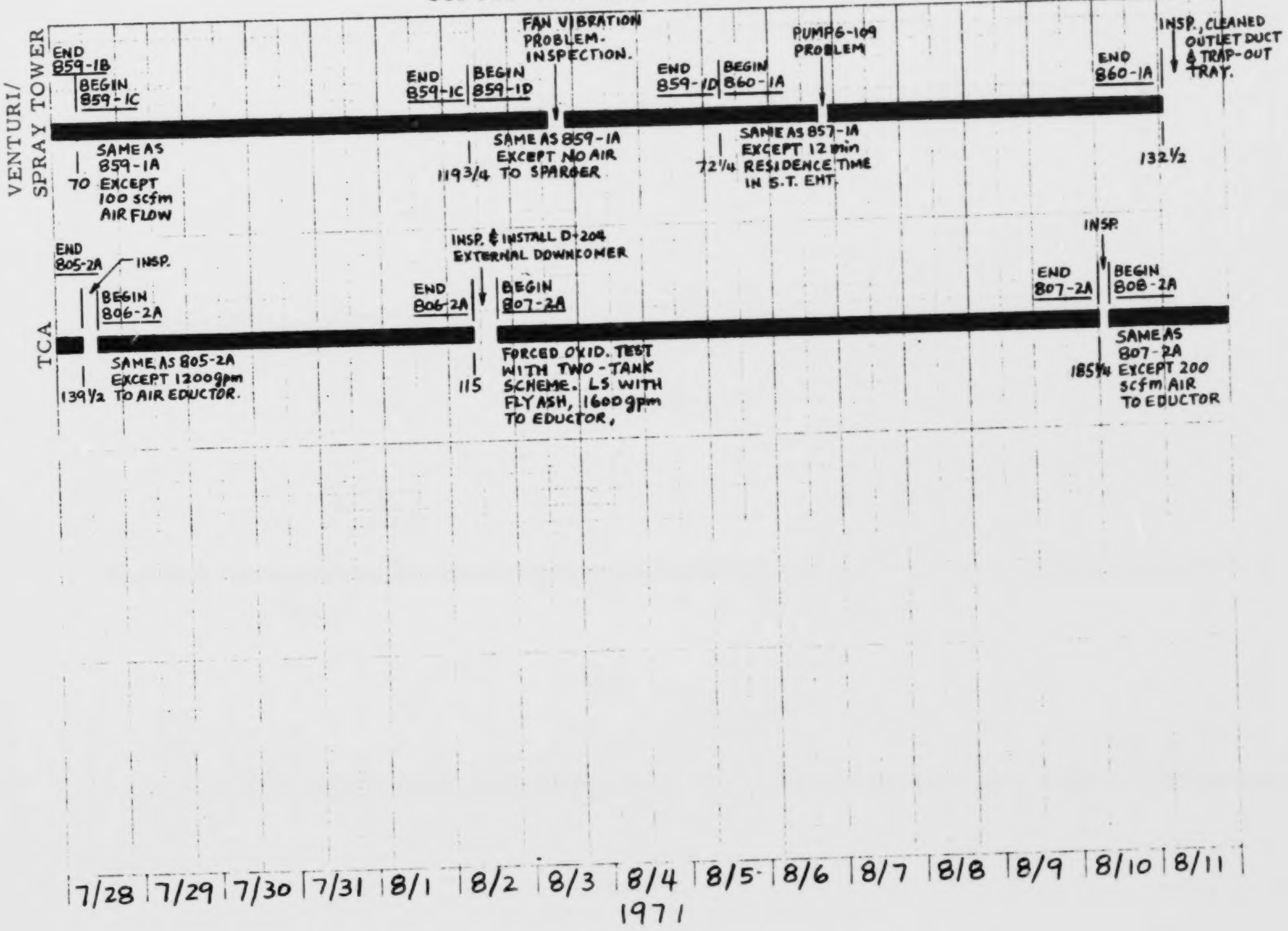

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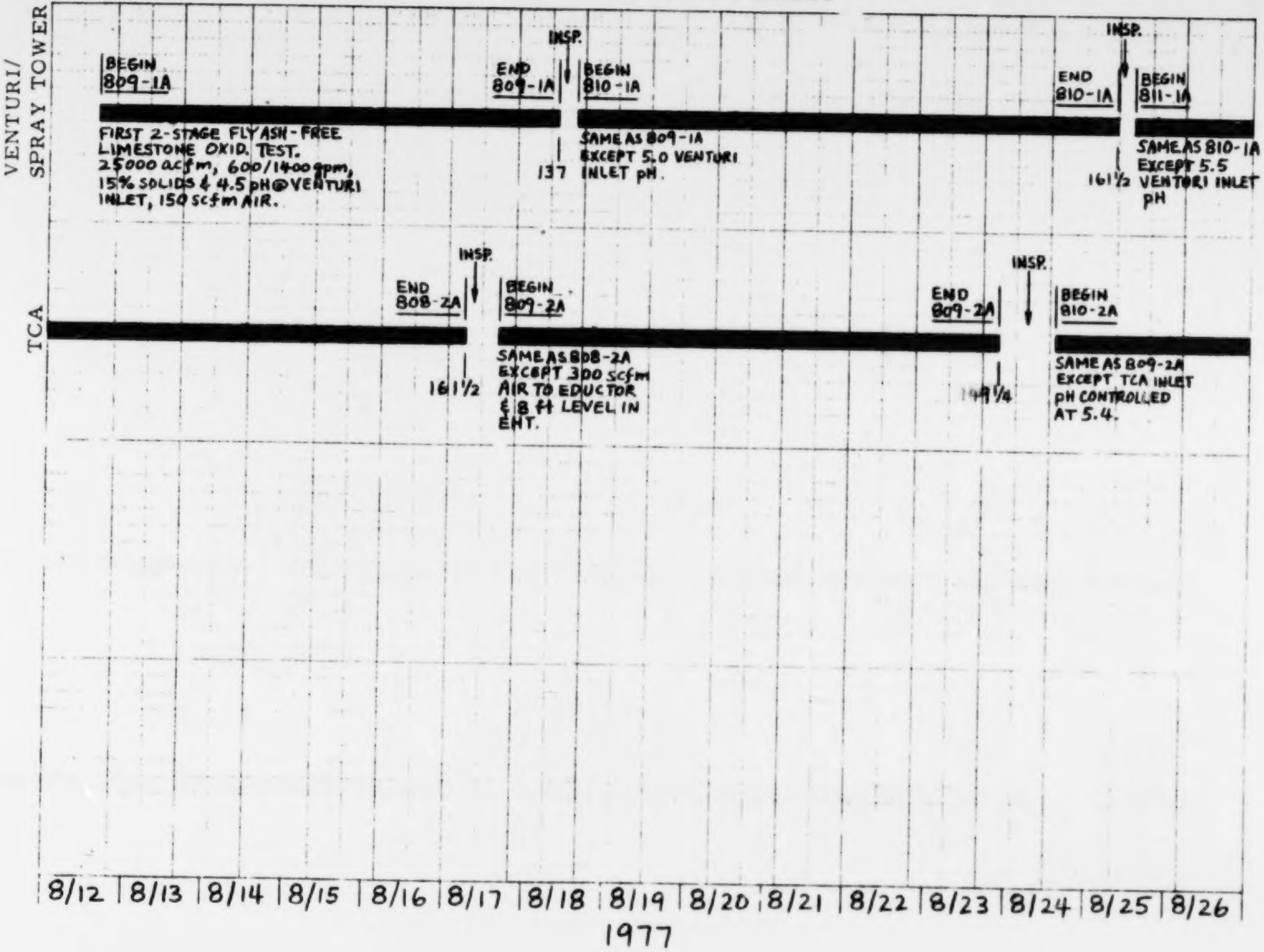
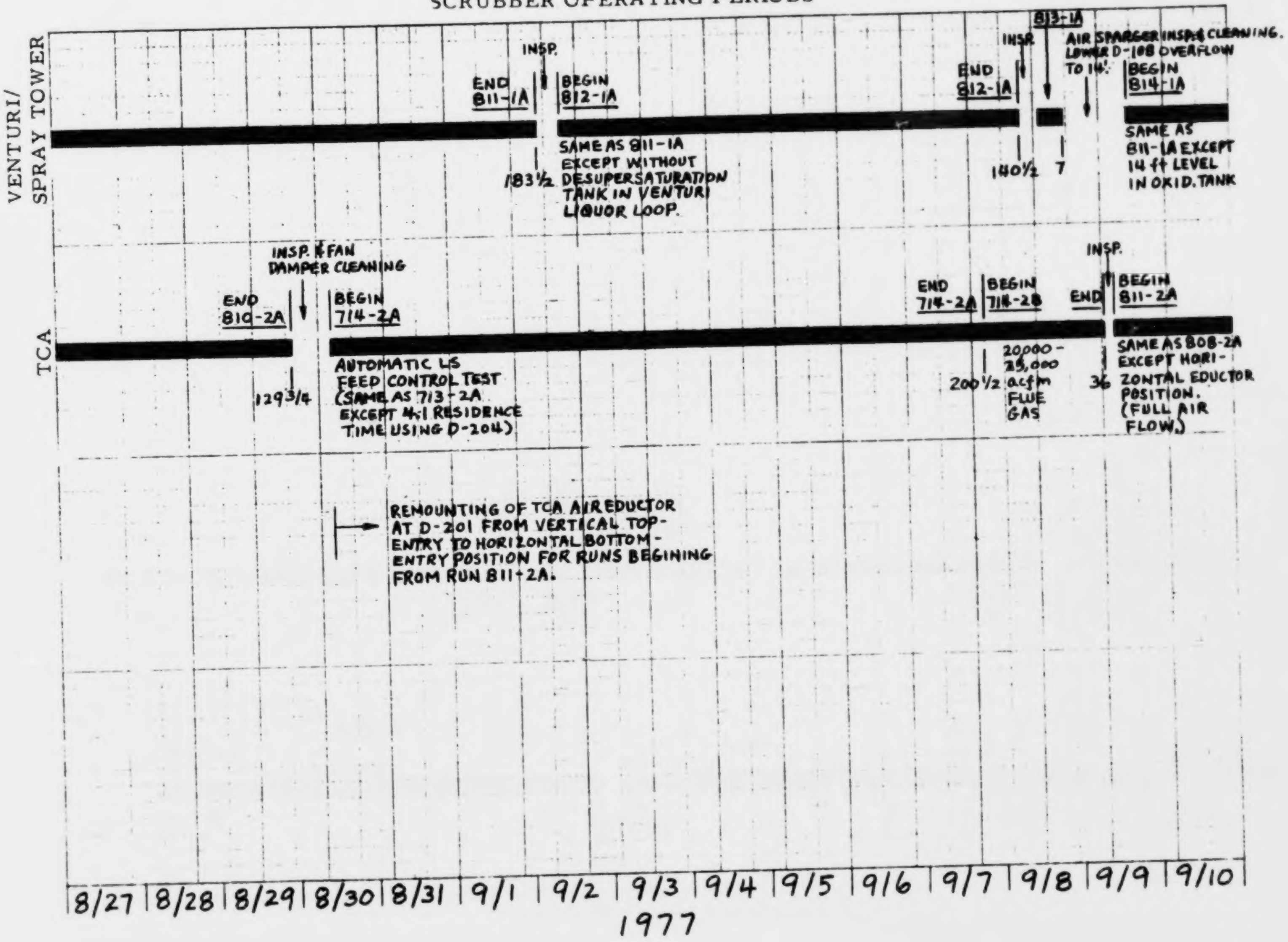
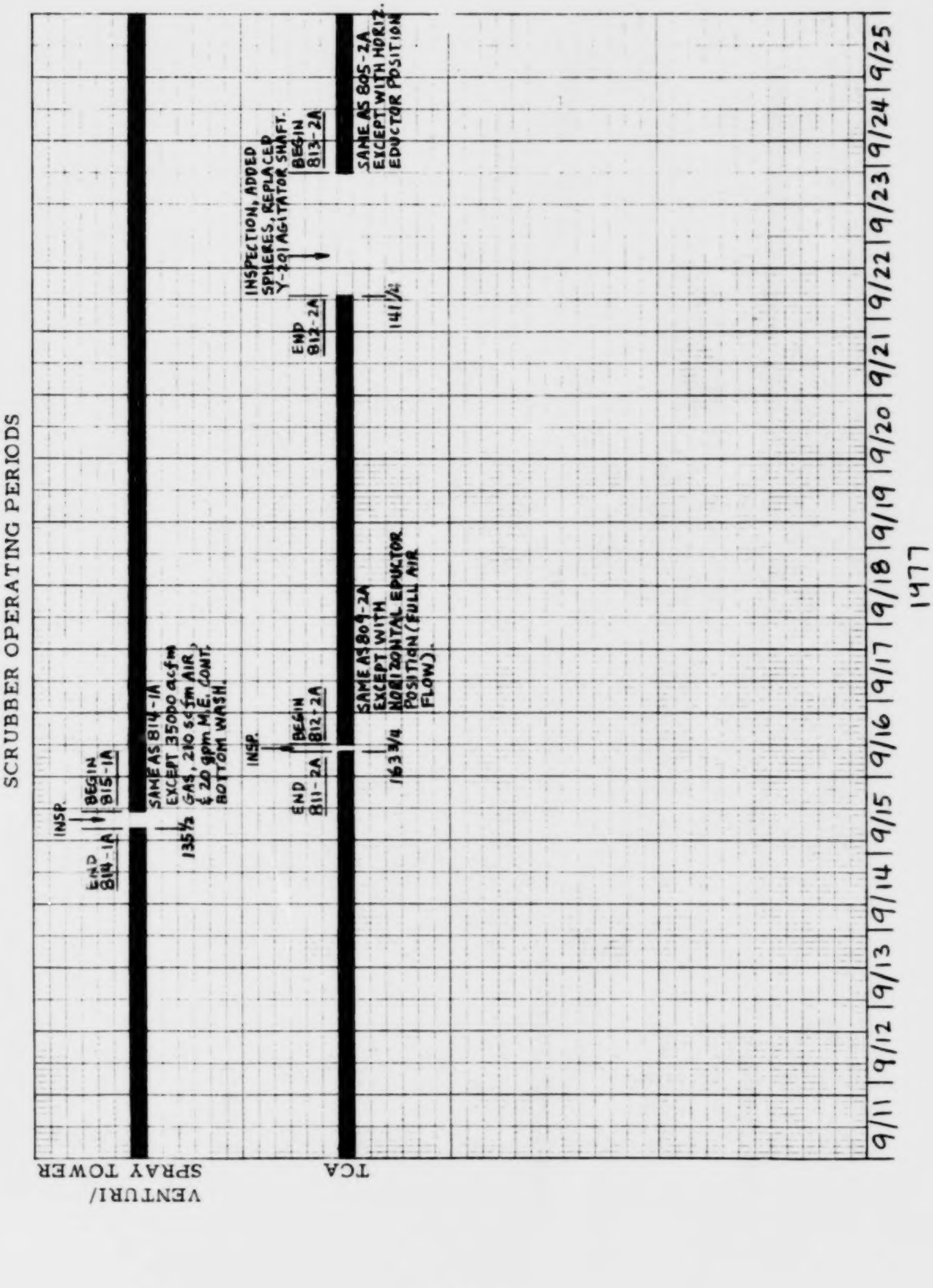


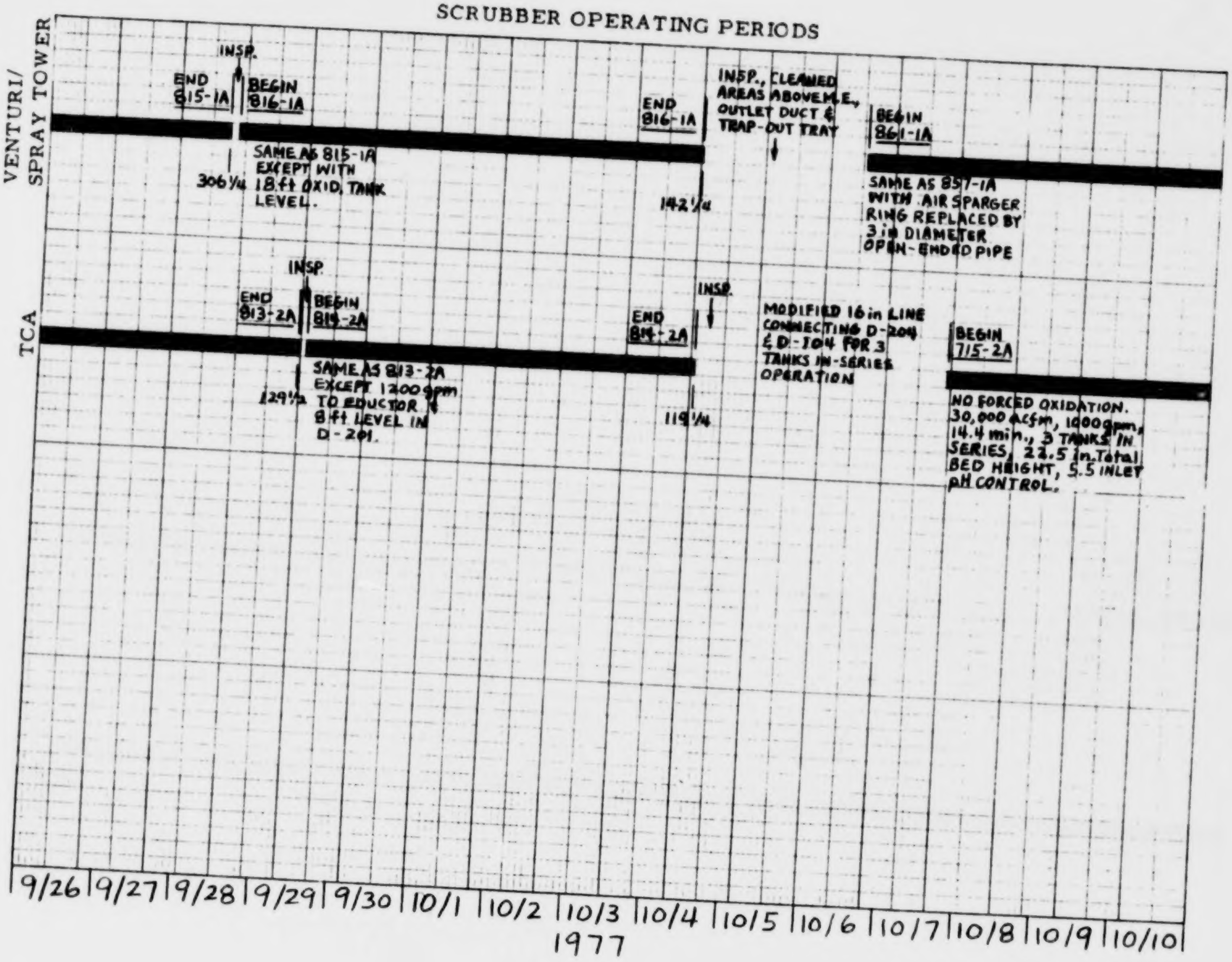
SCRUBBER OPERATING PERIODS





SCRUBBER OPERATING PERIODS

SCRUBBER OPERATING PERIODS



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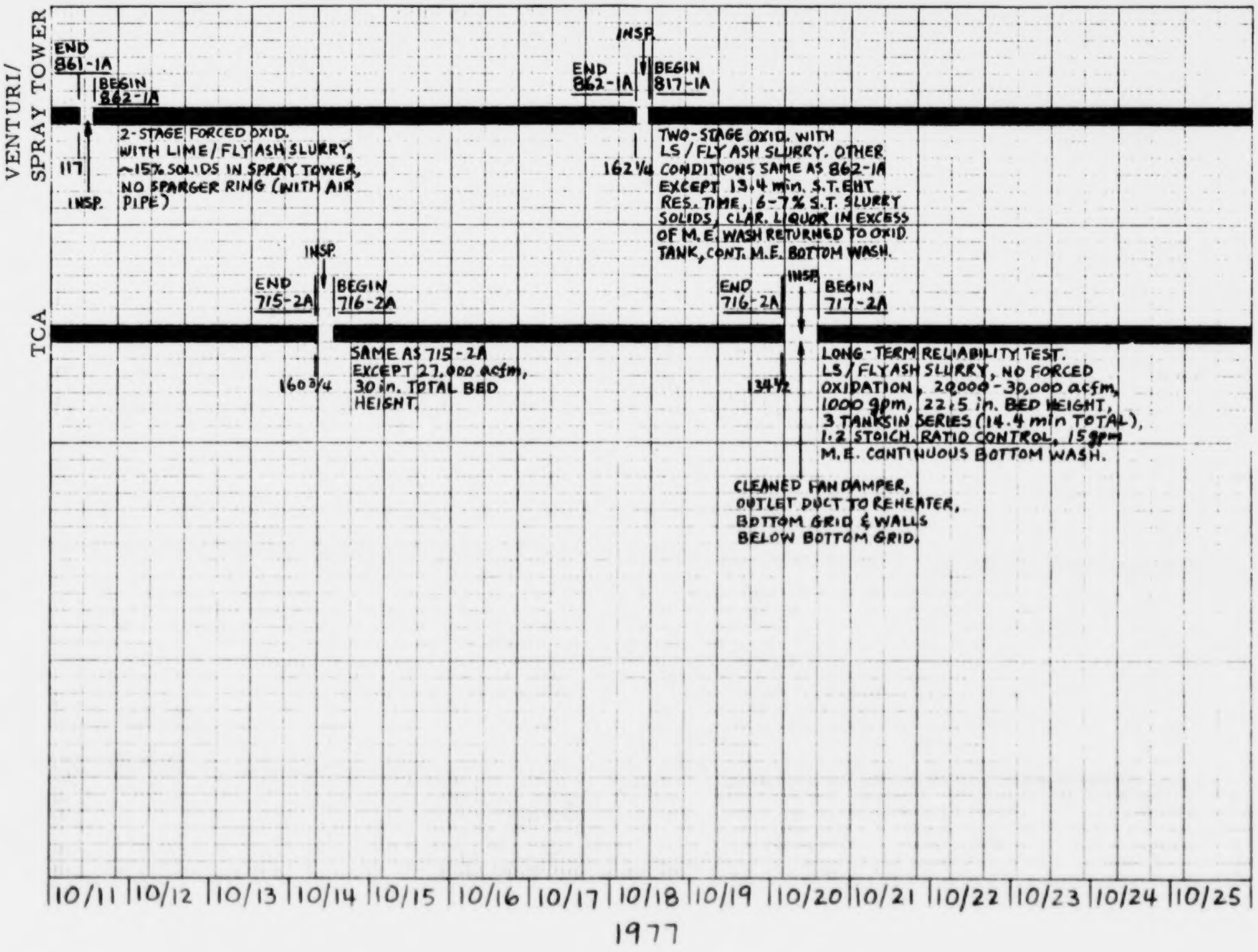


2-STAGE FORCED OXID. WITH LIME/FLY ASH SLURRY, ~15% SOLIDS IN SPRAY TOWER, NO SPARGER RING (WITH AIR PIPE)

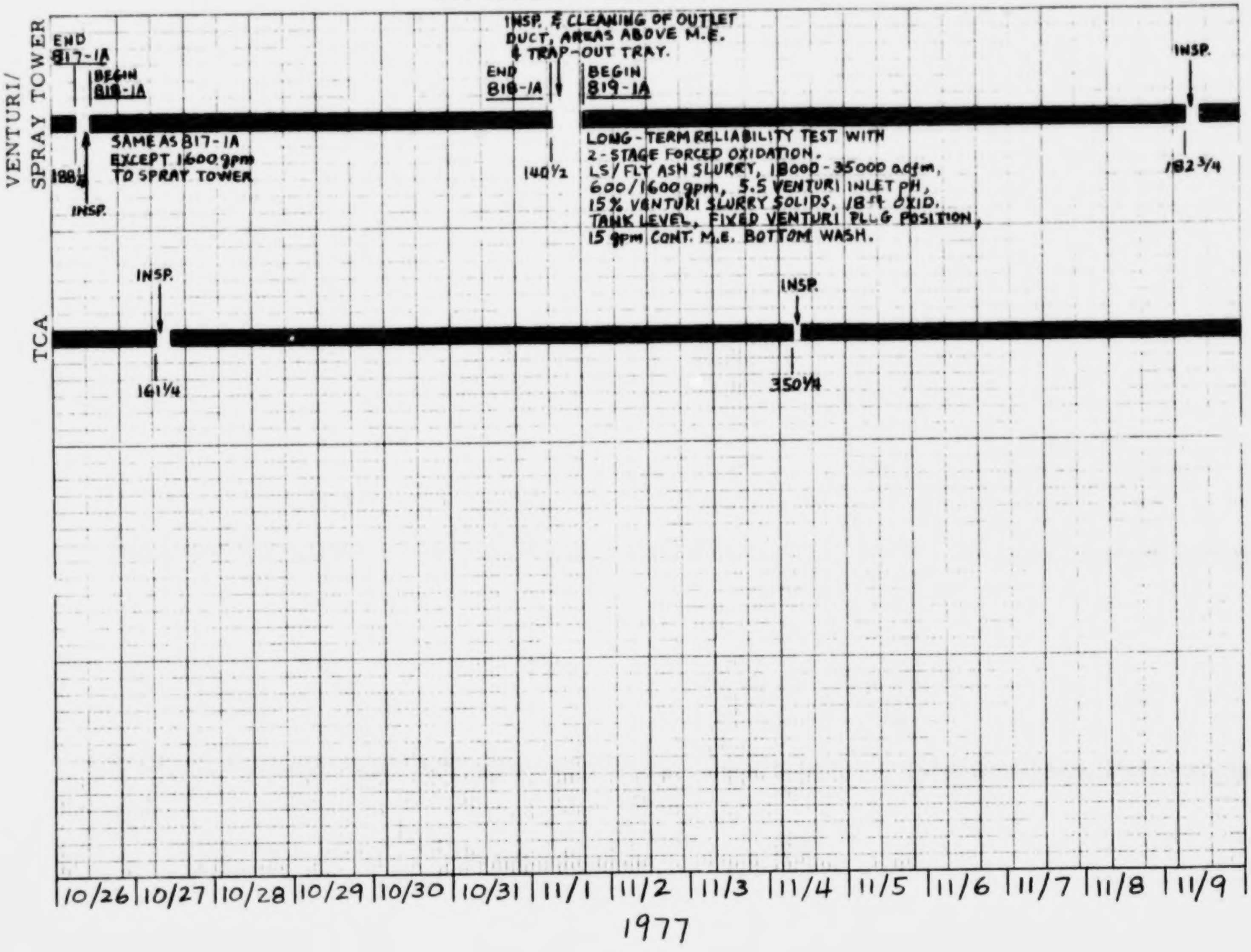
TWO-STAGE OXID. WITH LS/FLY ASH SLURRY. OTHER CONDITIONS SAME AS 862-1A EXCEPT 13.4 min. S.T. EHT RES. TIME, 6-7% S.T. SLURRY SOLIDS, CLAR. LIQUOR IN EXCESS OF M.E. WASH RETURNED TO OXID. TANK, CONT. M.E. BOTTOM WASH.

SAME AS 715-2A EXCEPT 27,000 acfm, 30 in. TOTAL BED HEIGHT.

LONG-TERM RELIABILITY TEST. LS/FLYASH SLURRY, NO FORCED OXIDATION, 20,000-30,000 acfm, 1000 gpm, 22.5 in. BED HEIGHT, 3 TANKS IN SERIES (14.4 min TOTAL), 1.2 STOICH. RATIO CONTROL, 15 gpm M.E. CONTINUOUS BOTTOM WASH.

CLEANED FAN DAMPER, OUTLET DUCT TO REHEATER, BOTTOM GRID & WALLS BELOW BOTTOM GRID.

SCRUBBER OPERATING PERIODS



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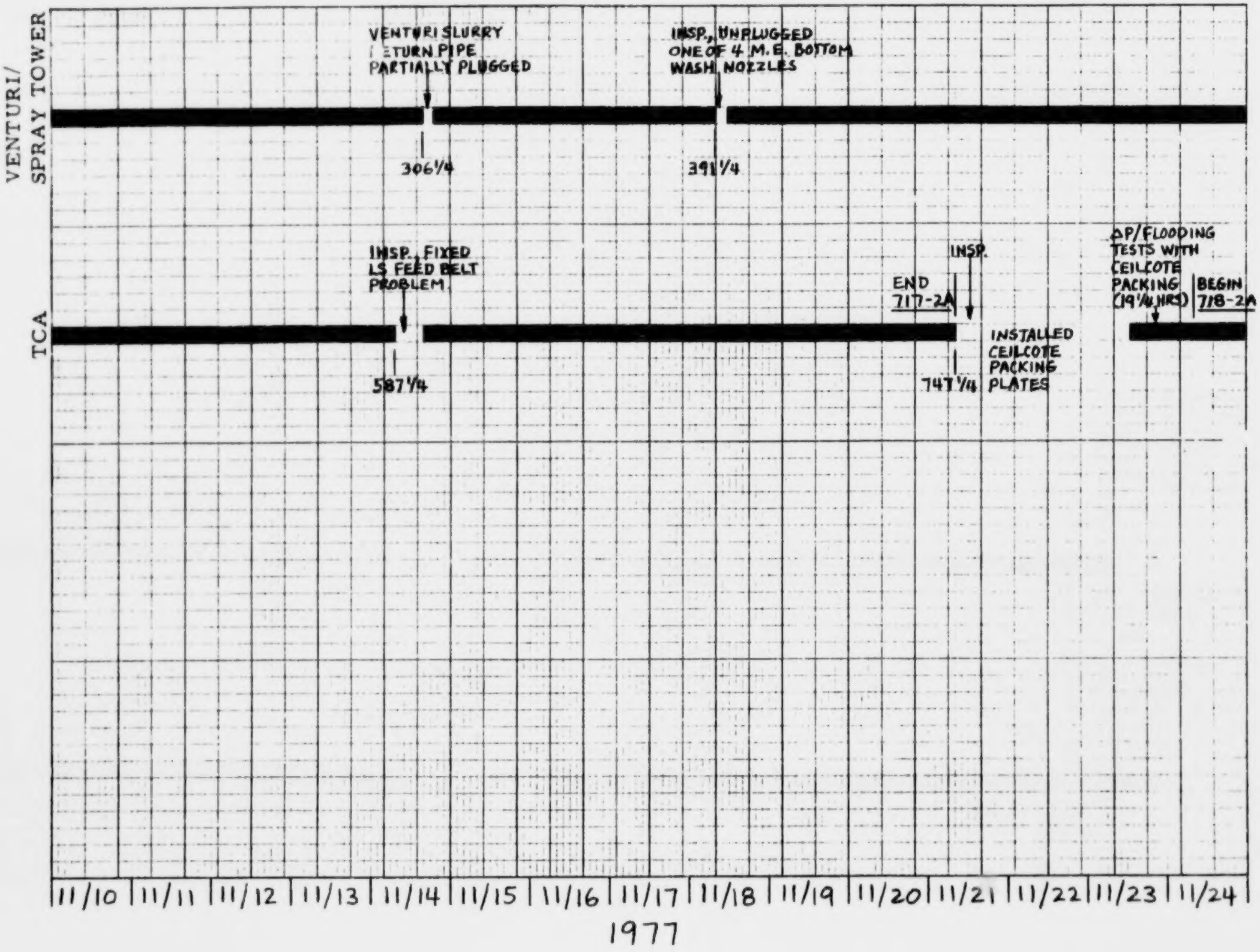

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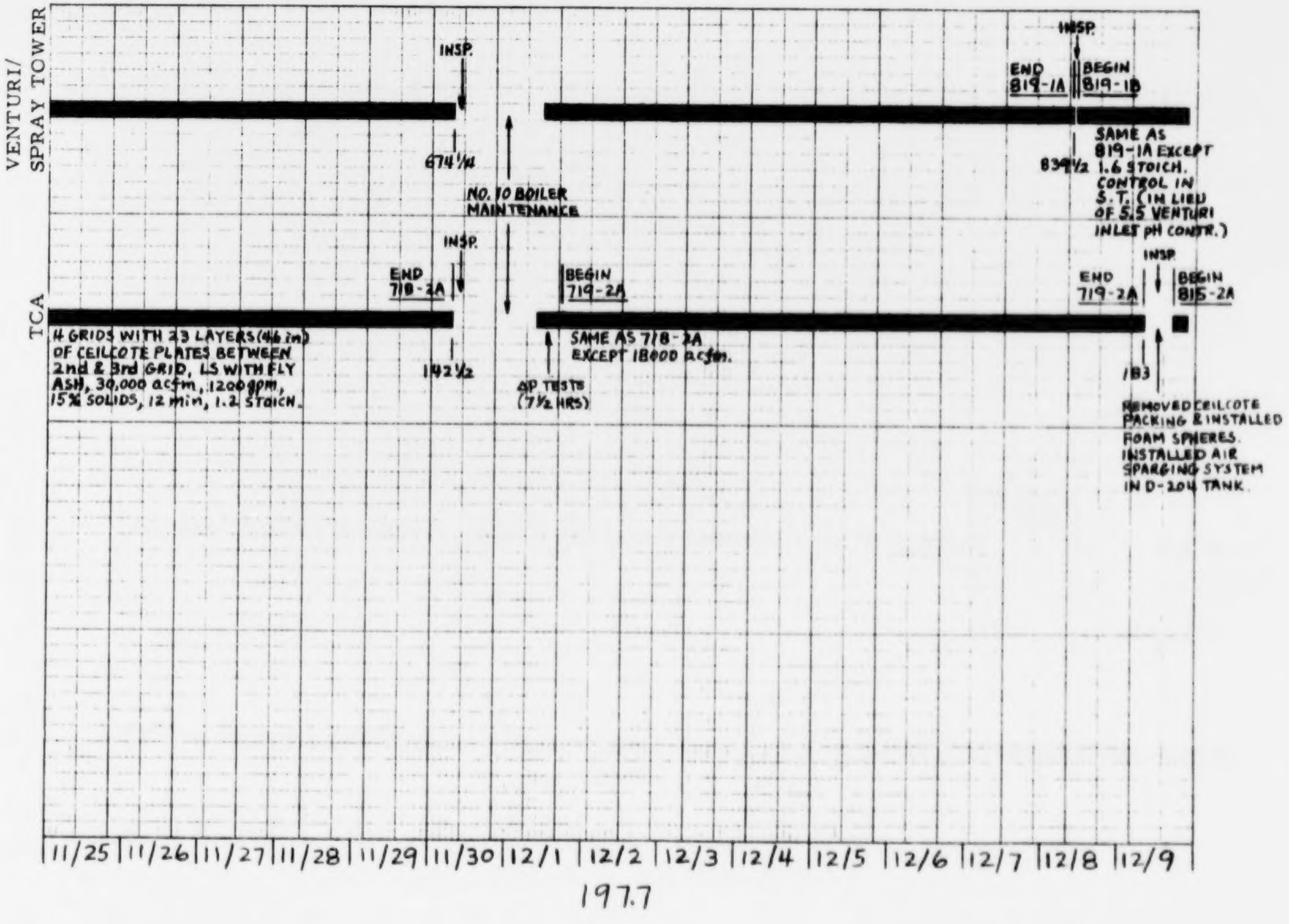

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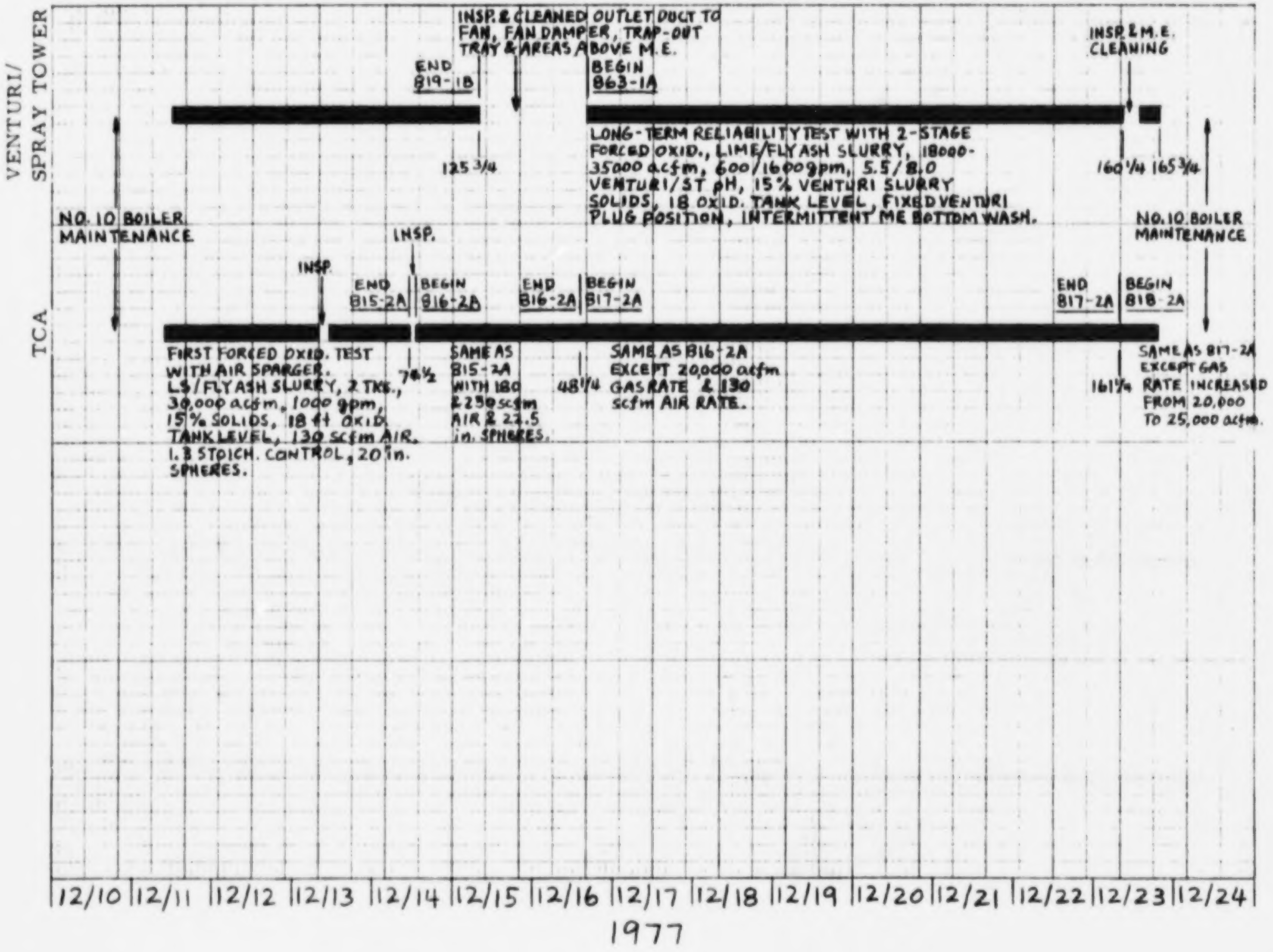

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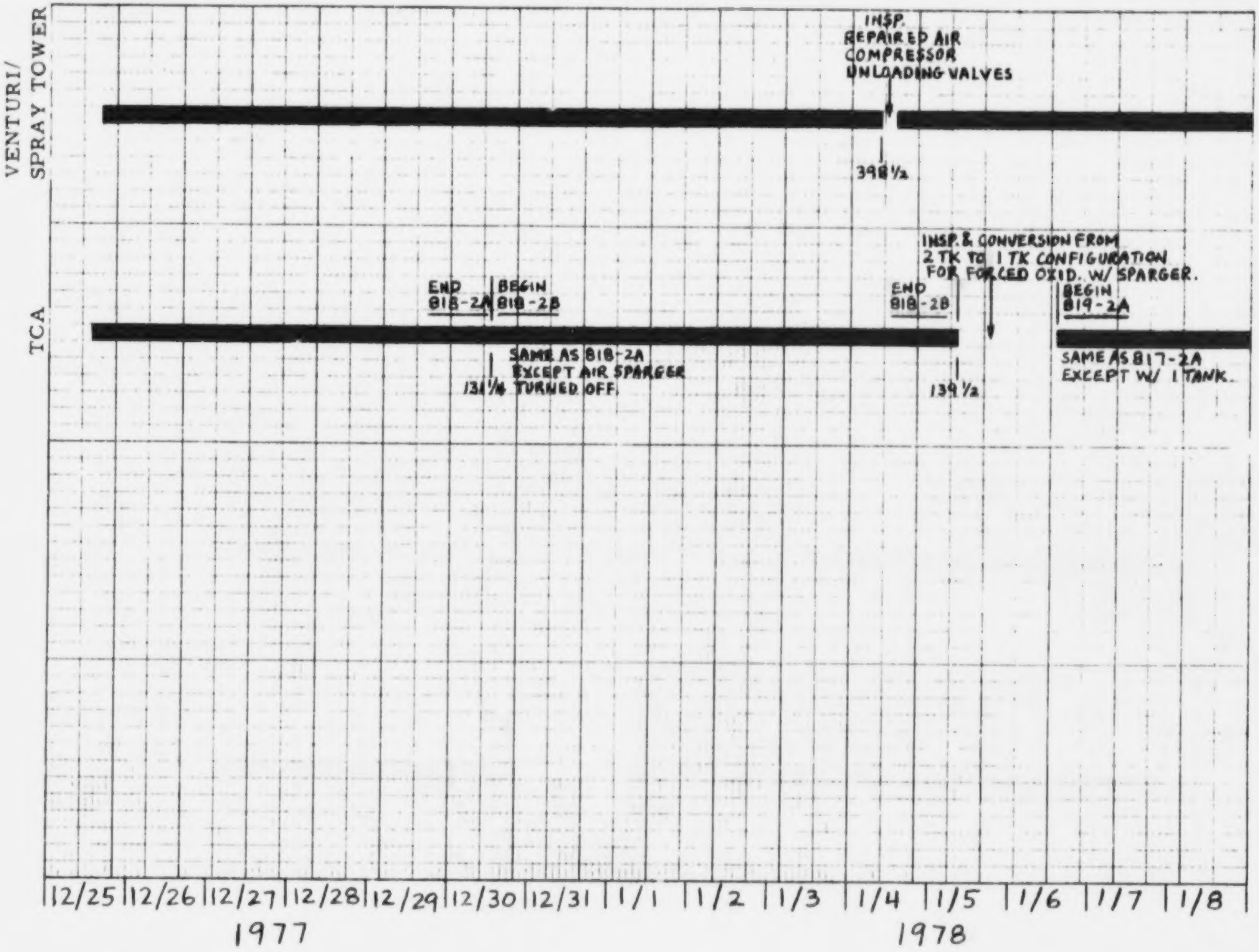

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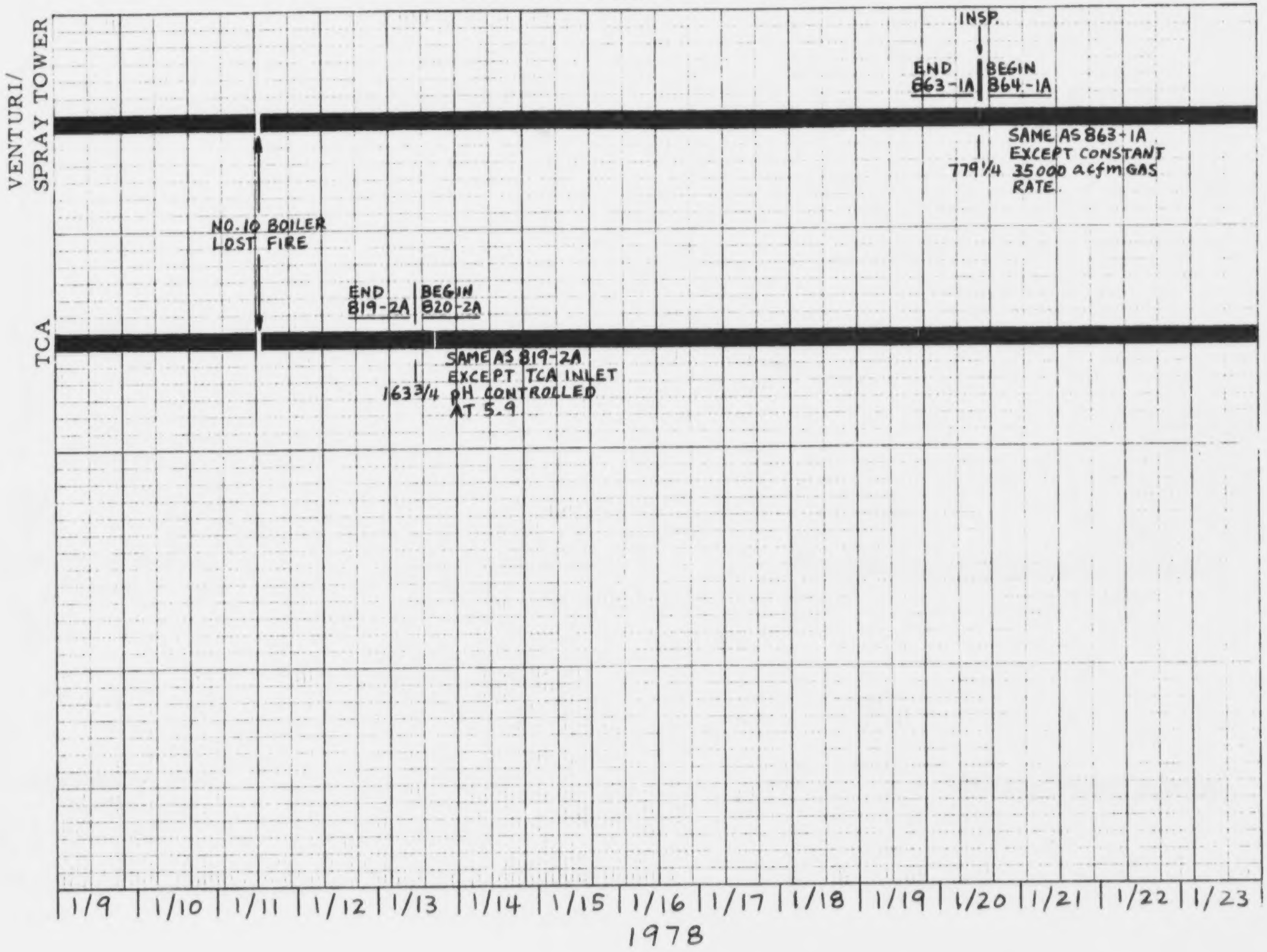

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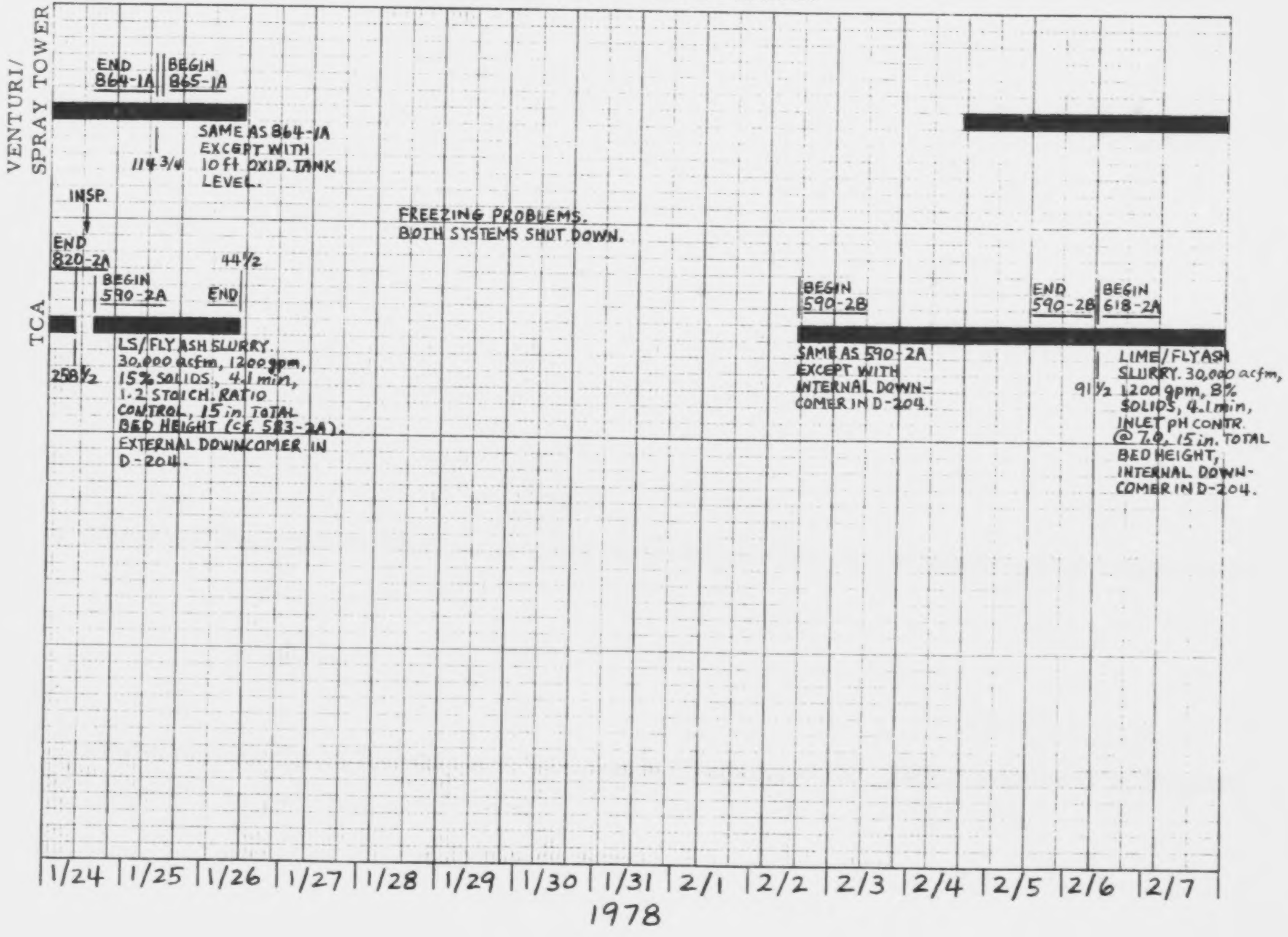

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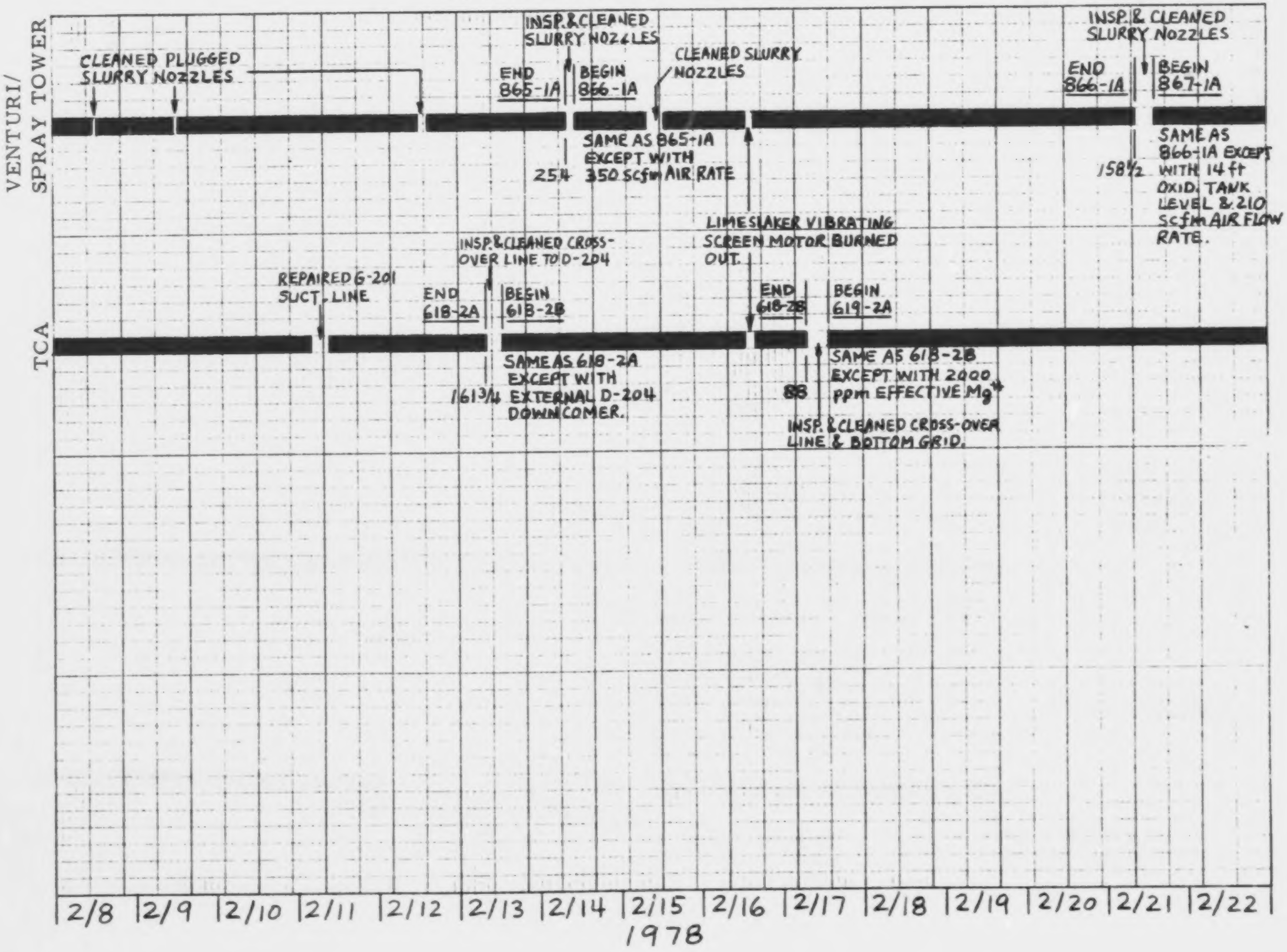

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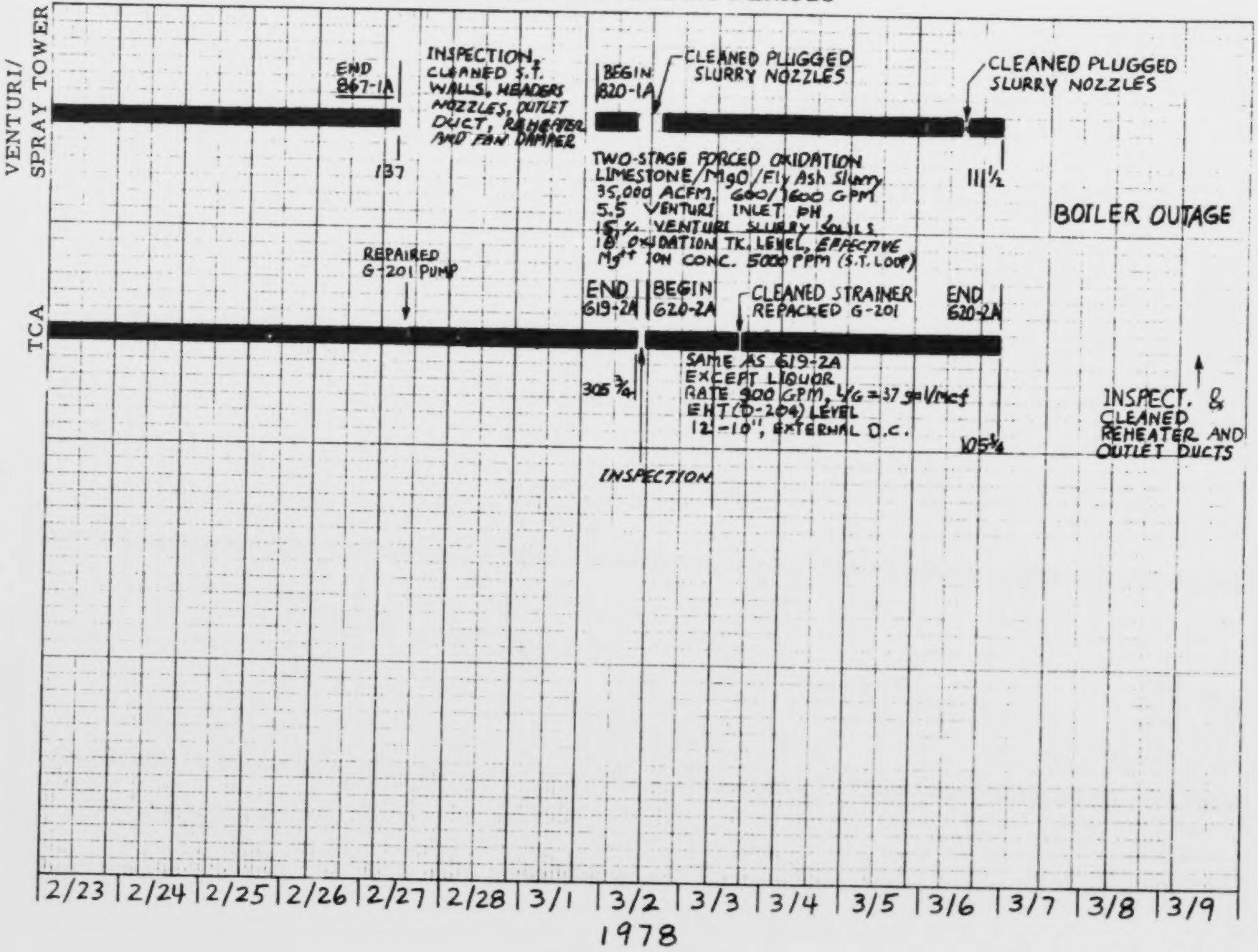

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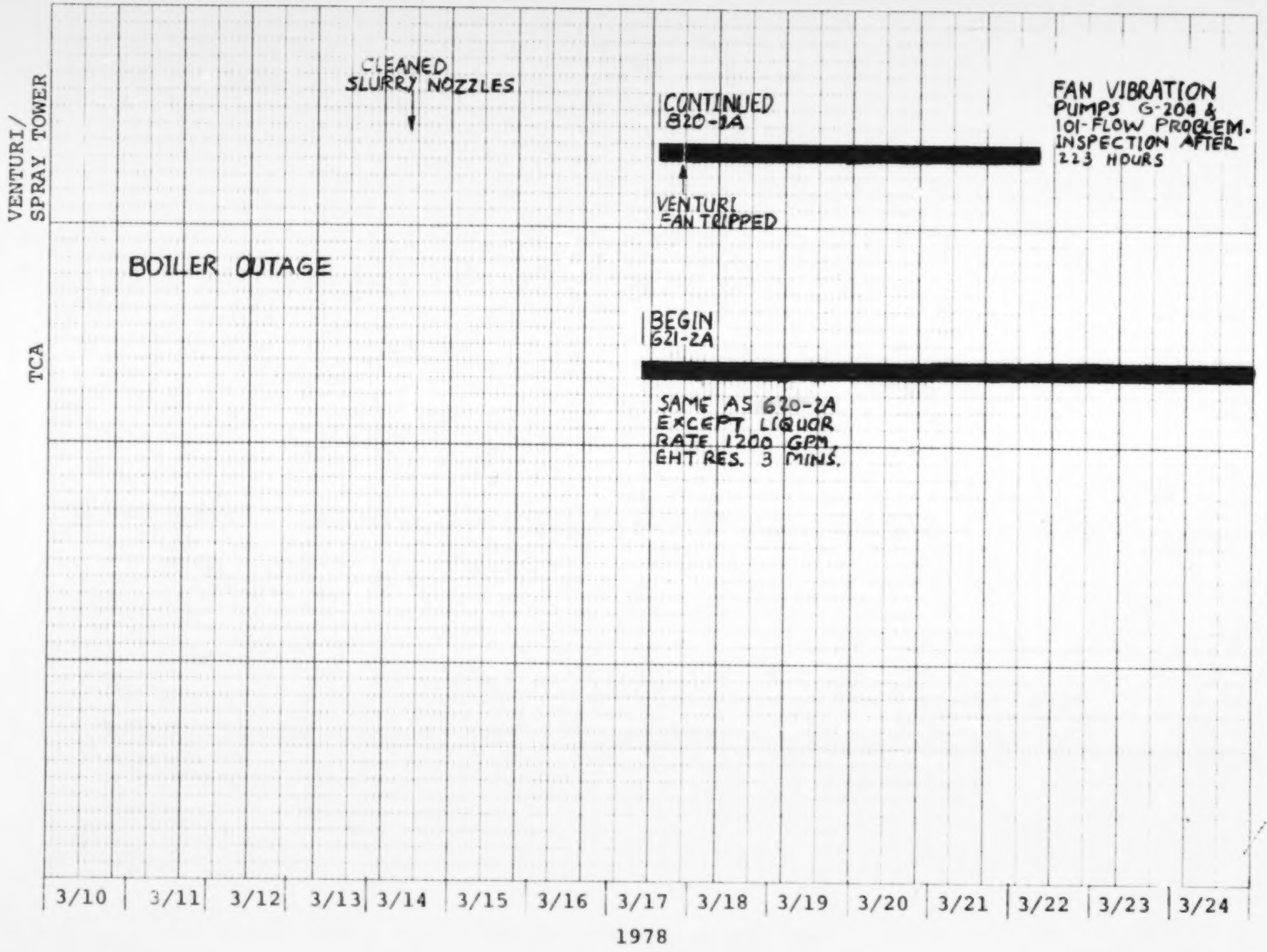

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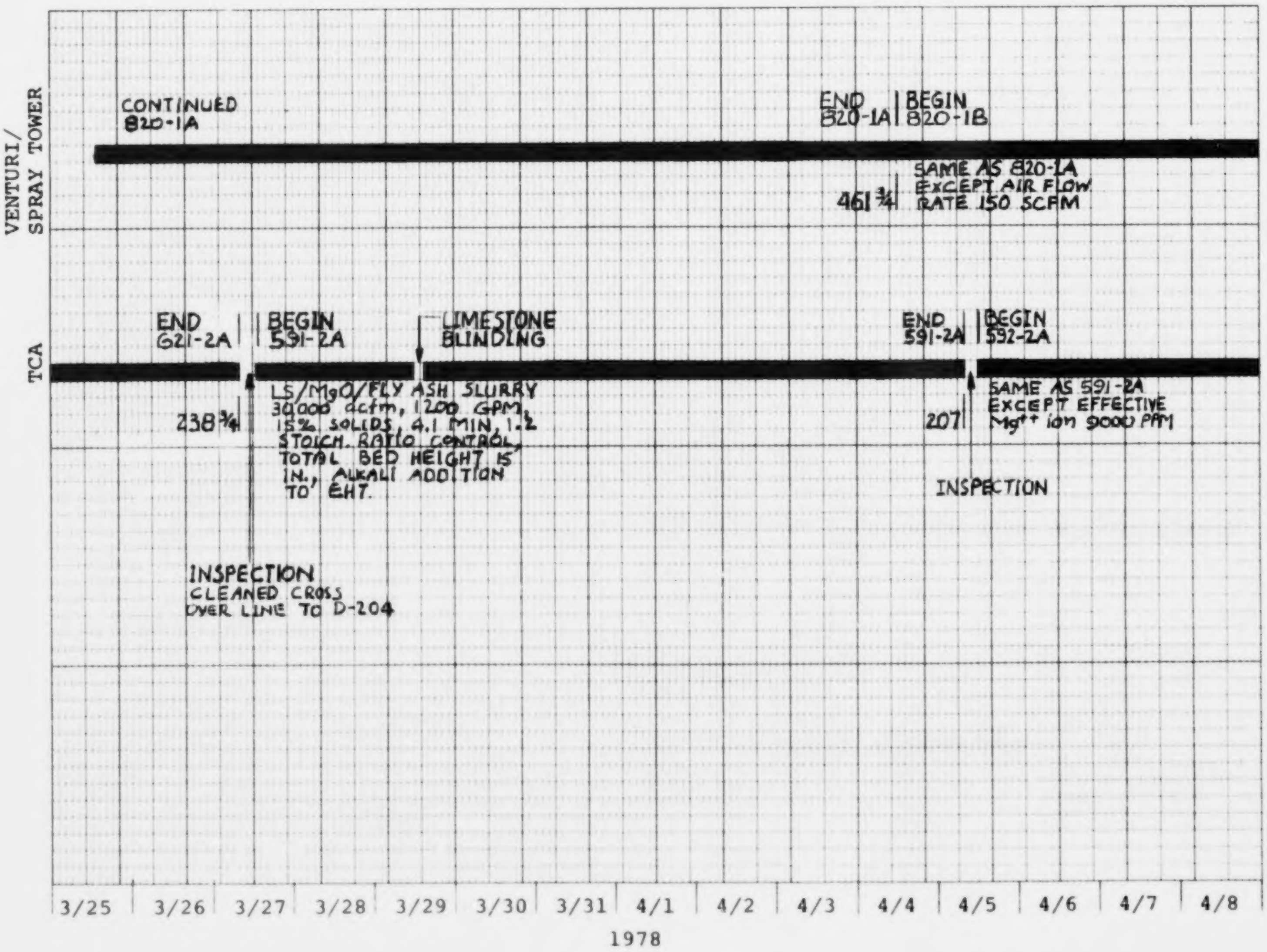

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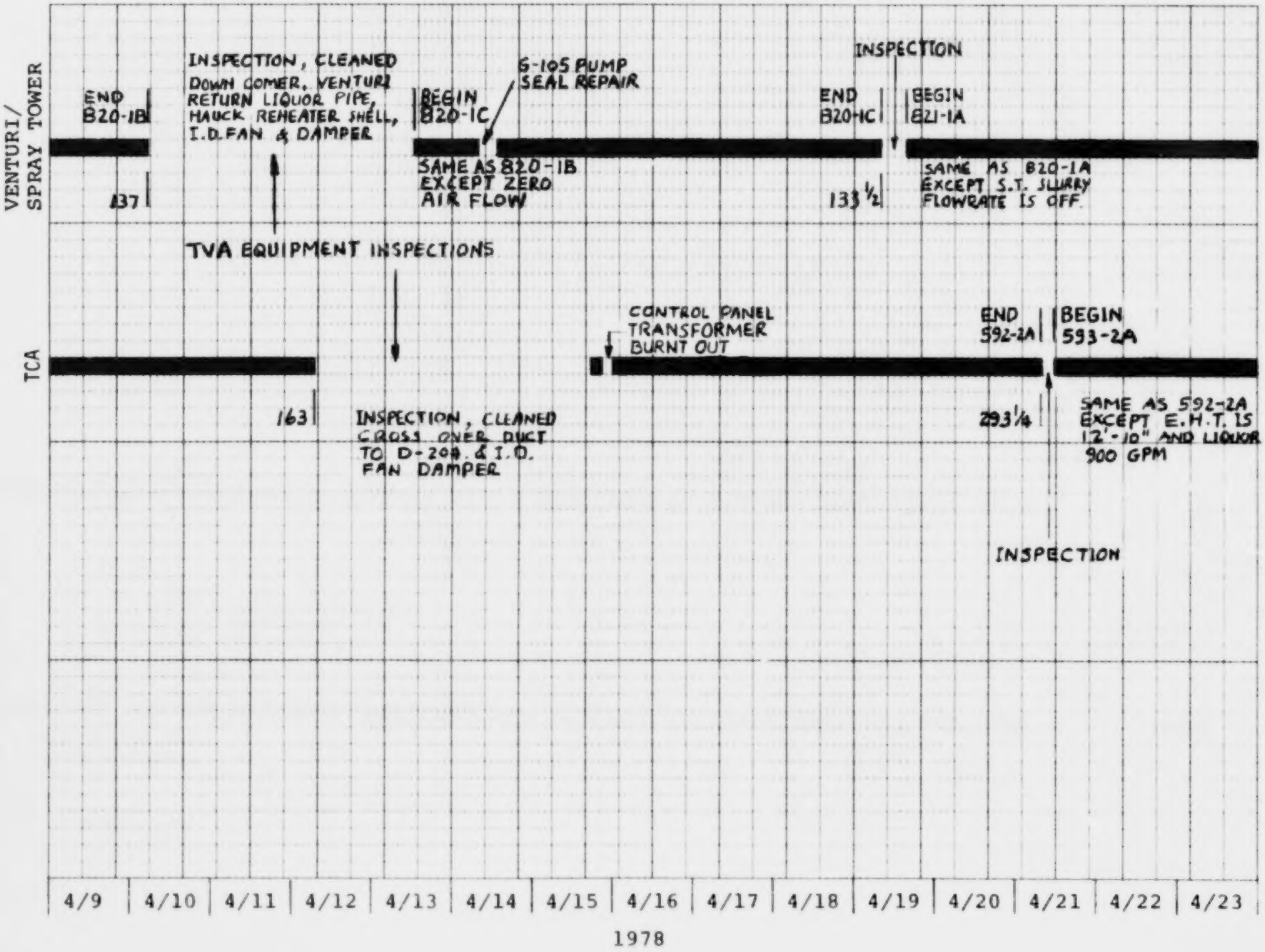

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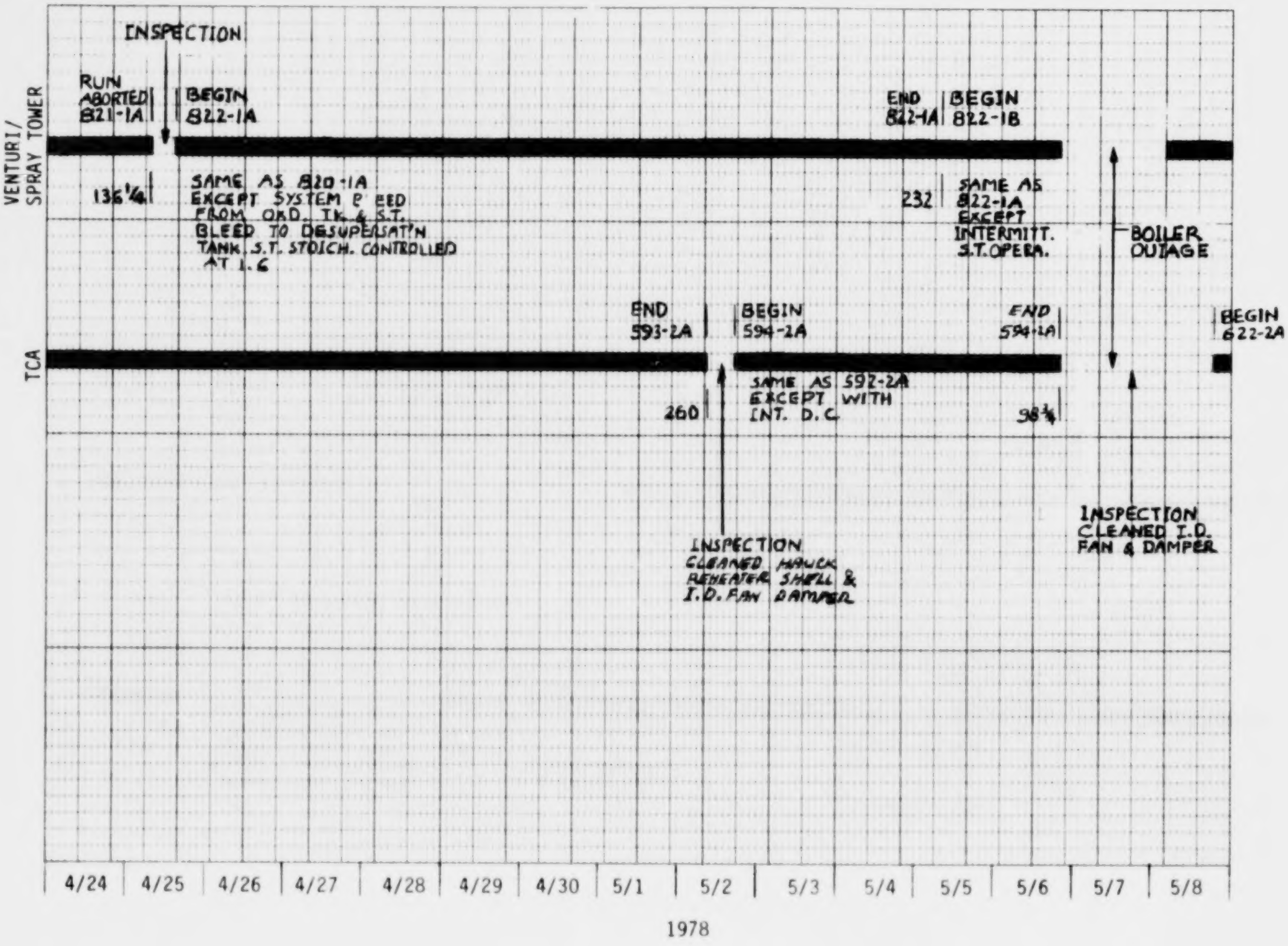

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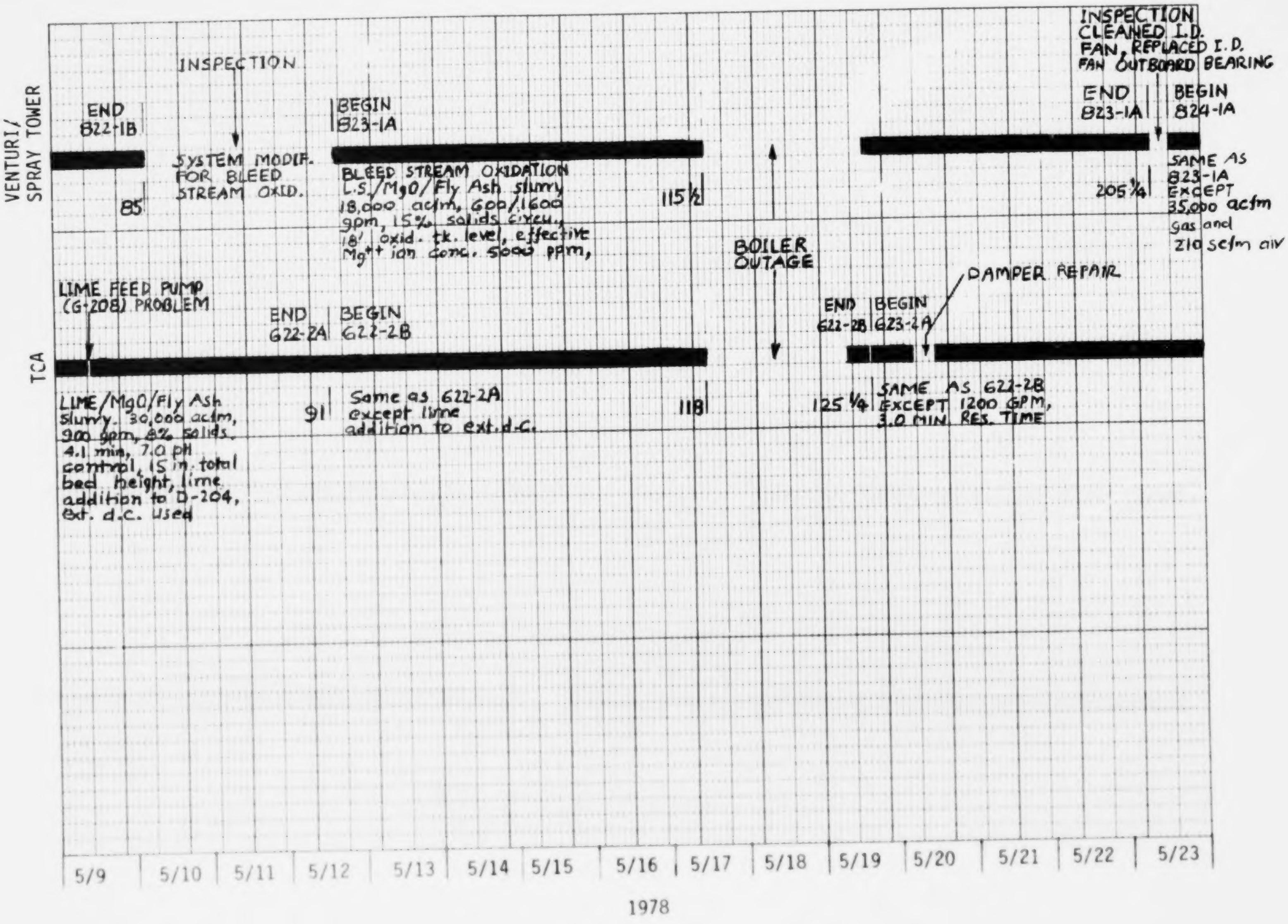

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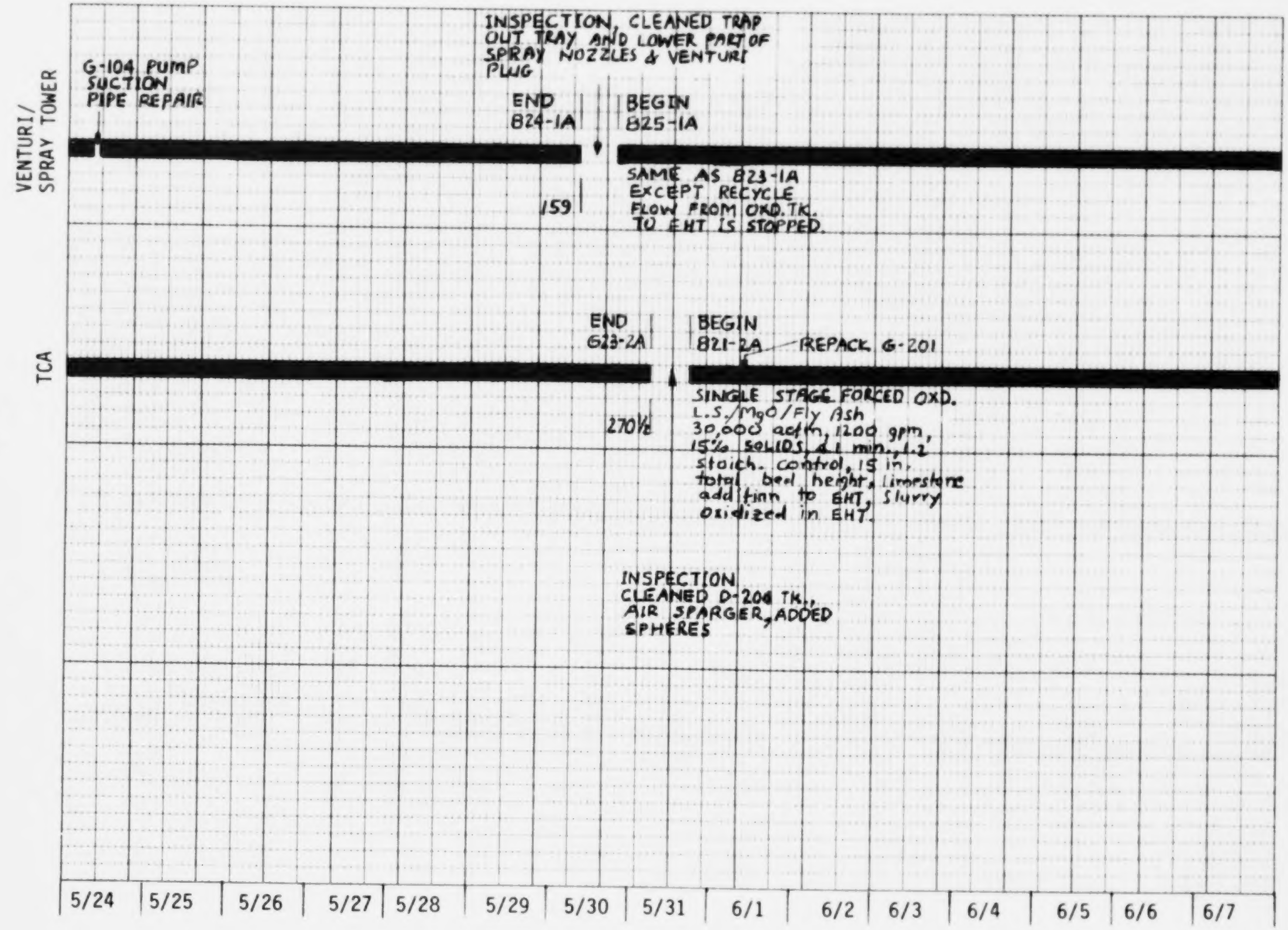
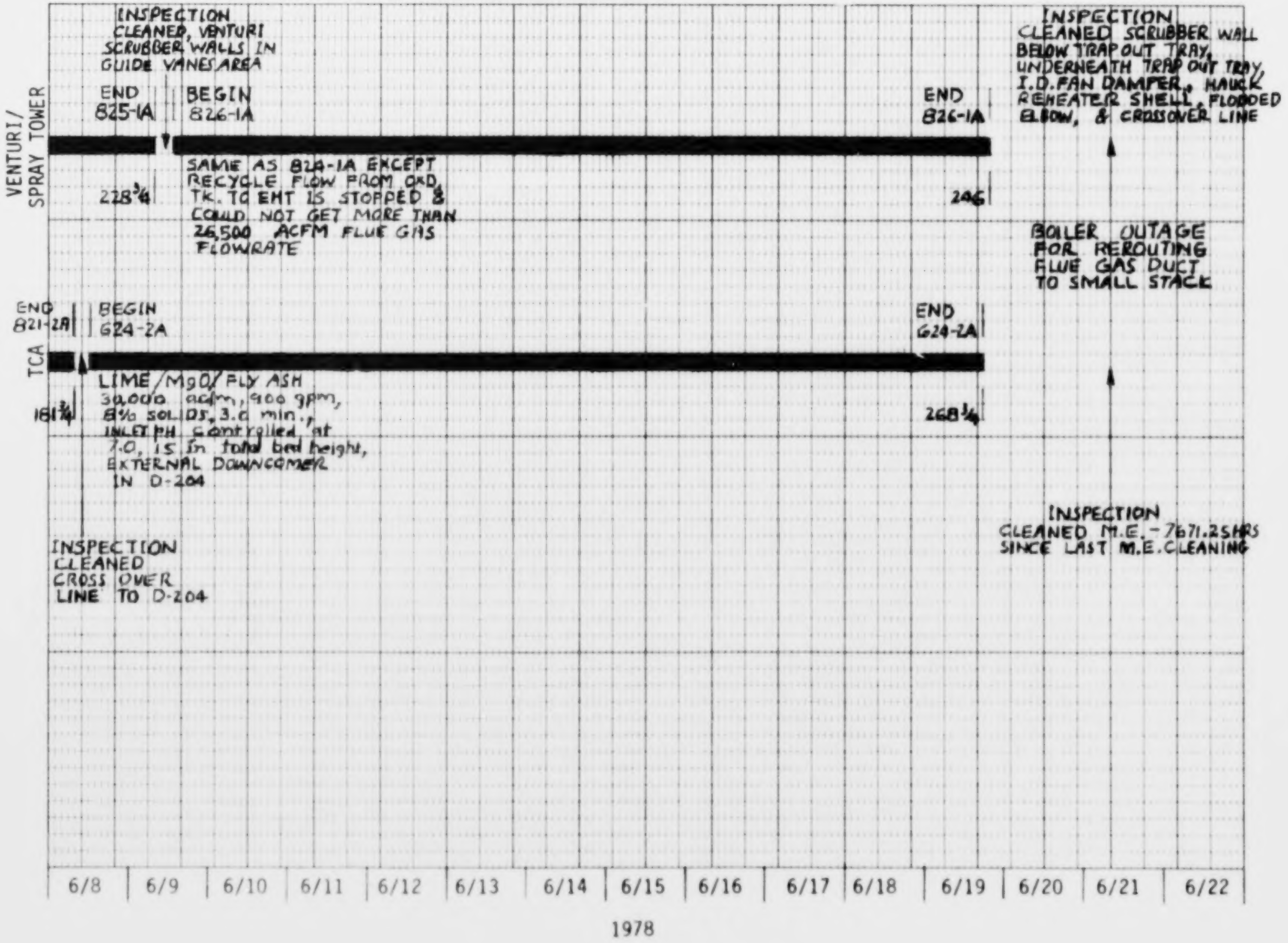


1978

SCRUBBER OPERATING PERIODS



APPENDIX C

PROPERTIES OF RAW MATERIALS

The following is a summary of the properties of the raw materials used from December 1976 to June 1978.

C.1 COAL*

Supplier: Several

Type: Eastern (Southern Illinois) high sulfur.

Analysis:

9.4	to	12.4	wt% total moisture
2.3	to	5.5	wt% sulfur
0.03	to	0.27	wt% chloride
13.0	to	16.3	wt% ash

Approximate Ash Analysis:

54 wt% SiO_2
23 wt% AL_2O_3
12 wt% Fe_2O_3
3 wt% CaO
1 wt% MgO
1 wt% SO_3
3 wt% K_2O
1 wt% Na_2O
3 wt% Ignition loss

* Note: During the coal miners' strike in the first quarter of 1978, any available coal was burned. Coal types included lignite and low sulfur western coals. Coals from more than 2 different sources were used.

C.2 LIMESTONE

C.2.1 Supplier: Fredonia Quarries, Fredonia, Kentucky

Type: Fredonia Valley White

Analysis:
96.8 wt% $CaCO_3$
0.9 wt% $MgCO_3$
2.3 wt% Inerts

Grind; Fine:
96 wt% less than 325 mesh
89 wt% less than 30 microns
88 wt% less than 27 microns
58 wt% less than 6 microns
40 wt% less than 3 microns

Grind; Coarse:
81 wt% less than 200 mesh
60 wt% less than 30 microns
31 wt% less than 6 microns
21 wt% less than 3 microns

C.2.2 Supplier: Longview Lime Company, Longview, Alabama

Type: Longview

Analysis:
97.5 wt% $CaCO_3$
1.2 wt% $MgCO_3$
1.3 wt% Inerts

Grind:
75 wt% less than 200 mesh
59 wt% less than 30 microns
27 wt% less than 6 microns
16 wt% less than 3 microns

C.3 LIME

Supplier:	Linwood Stone Co., Davenport, Iowa (through 9/75) Mississippi Lime Co., Alton, Illinois (after 9/75)
Type:	Pebble Lime, unslaked
Analysis:	97.0 wt% CaO total 95.5 wt% CaO available 0.28 wt% MgO 0.47 wt% Inerts

C.4 MAGNESIUM OXIDE

Supplier:	Basic Chemicals, Ft. St. Joe, Florida
Type:	MAFOX PG (pollution grade)
Analysis:	97.6 wt% MgO 1.5 wt% CaO 0.5 wt% SiO_2 0.4 wt% R_2O_3

APPENDIX D

DATABASE SUMMARY

The NOMAD database system can be used to print reports of selected data. The run summary table reports for the period December 4, 1976 through June 19, 1978 are presented in this appendix.

The following codes and abbreviations are used in describing the operating conditions and the system configuration:

- Alkali type
    - L = lime
    - LS = limestone
- Fly ash and MgO addition
    - Y = yes
    - N = no
- Spray tower header configuration
    - 1 = lowest nozzle bank
    - 2 = second lowest
    - 3 = second highest
    - 4 = highest
- Mist eliminator system configuration
    - 1-3P/OV = one three-pass, open-vane mist eliminator
- Mist eliminator wash, bottom/top
    - C = continuous
    - I = intermittent
    - S = sequential
- Dewatering system
    - CL = clarifier
    - CE = centrifuge
    - F = filter
    - i.e., CL/CE = clarifier and centrifuge in series
- Alkali addition point
    - DNC = downcomer
    - EHT = effluent hold tank
- TCA total bed height is given in inches for 3 beds

- TCA sphere type
  FOAM = 1 5/8-inch solid nitrile foam spheres

The analytical point designations are as follows:

1815 = venturi inlet
1816 = spray tower inlet
1825 = spray tower outlet
1851 = venturi outlet
2816 = TCA inlet
2825 = TCA outlet

VST RUN DEFINITION

RUN NO.	START DATE	START TIME	END DATE	END TIME	HOURS ON STRM	FACT OR TIME
801-1A	01/04/77	1420	01/15/77	1255	263	T
802-1A	01/24/77	1550	02/04/77	0805	256	T
803-1A	02/04/77	1400	02/10/77	0730	138	T
804-1A	02/10/77	1210	02/18/77	0205	151	T
805-1A	02/18/77	1620	02/23/77	0800	112	T
806-1A	02/23/77	1440	02/25/77	1130	45	T
806-1B	02/25/77	1130	02/27/77	0815	45	T
806-1C	02/27/77	0815	03/01/77	1415	54	T
806-1D	03/01/77	1500	03/03/77	0800	41	T
807-1A	03/03/77	1630	03/06/77	1015	66	T
808-1A	03/06/77	1015	03/09/77	0330	65	T
809-1A	08/12/77	1510	08/18/77	0820	137	T
810-1A	08/18/77	1355	08/25/77	0735	162	T
811-1A	08/25/77	1245	09/02/77	0410	184	T
812-1A	09/02/77	1108	09/08/77	0752	141	T
814-1A	09/08/77	1620	09/15/77	0746	136	T
815-1A	09/15/77	1320	09/28/77	0730	306	T
816-1A	09/28/77	1005	10/04/77	0820	142	T
817-1A	10/18/77	1110	10/26/77	0727	188	T
818-1A	10/26/77	1155	11/01/77	0735	141	T
819-1A	11/01/77	1655	12/08/77	0850	840	T
819-1B	12/08/77	1032	12/15/77	0739	126	T
820-1A	03/01/78	2030	04/04/78	0800	462	T
820-1B	04/04/78	1230	04/10/78	0505	137	T
820-1C	04/13/78	1230	04/19/78	0815	134	T
821-1A	04/19/78	1545	04/25/78	0750	136	T
822-1A	04/25/78	1440	05/05/78	0740	232	T
822-1B	05/05/78	0740	05/10/78	0455	85	T
823-1A	05/12/78	1630	05/23/78	0800	205	T
824-1A	05/23/78	1435	05/30/78	0800	159	T
825-1A	05/30/78	1900	06/09/78	0800	229	T
826-1A	06/09/78	1335	06/19/78	1925	246	T
851-1A	03/10/77	1450	03/15/77	0750	110	T
852-1A	03/15/77	1422	03/18/77	1550	74	T
853-1A	03/18/77	1550	03/25/77	0815	161	T
854-1A	03/25/77	1525	04/01/77	1315	166	T
855-1A	06/21/77	1510	06/28/77	1300	158	T
856-1A	06/28/77	1300	07/07/77	0815	209	T
857-1A	07/07/77	1416	07/12/77	2150	128	T
858-1A	07/13/77	1355	07/20/77	0810	162	T
859-1A	07/20/77	1440	07/25/77	1000	115	T
859-1B	07/25/77	1000	07/28/77	0800	70	T
859-1C	07/28/77	0800	08/02/77	0750	120	T
859-1D	08/02/77	0750	08/05/77	1330	72	T

VST RUN DEFINITION

RUN NO.	START DATE	START TIME	END DATE	END TIME	HOURS ON STRM	FACT OR TIME
860-1A	08/05/77	1330	08/11/77	0537	133	T
861-1A	10/06/77	1125	10/11/77	0825	117	T
862-1A	10/11/77	1300	10/18/77	0720	162	T
863-1A	12/16/77	1615	01/20/78	1241	779	T
864-1A	01/20/78	1309	01/25/78	0755	115	T
865-1A	01/25/78	1008	02/14/78	0835	254	T
866-1A	02/14/78	1030	02/21/78	0855	159	T
867-1A	02/21/78	1430	02/27/78	0820	137	T

VST SYSTEM CONFIGURATION

RUN NO.	NO. OF SCRUBBER STAGES	S.T. HEADER CONFIG	NO.OF HOLD TANKS	M.E. SYSTEM CONFIG	M.E. WASH B/T	DE-WATER SYSTEM	OXID CONFIG FLAG	SPARGER HOLE DIAM., INCHES	NO. OF HOLES IN SPARGER	SPARGE TANK AGITATOR	ALK ADDN PT.	PRESCRUB ALKALI ADDITION POINT	RUN NO.
801-1A	2	1234	1	1-3P/OV	I/I	CL/F		0.125	130	Y	EHT		801-1A
802-1A	2	1234	1	1-3P/OV	I/I	CL/F		0.125	130	Y	EHT		802-1A
803-1A	2	1234	1	1-3P/OV	I/I	CL/F		0.125	130	Y	EHT		803-1A
804-1A	2	1234	1	1-3P/OV	I/I	CL/F		0.125	130	Y	EHT		804-1A
805-1A	2	1234	1	1-3P/OV	I/I	CL/F		0.125	130	Y	EHT		805-1A
806-1A	2	1234	1	1-3P/OV	I/I	CL/F		0.125	130	Y	EHT		806-1A
806-1B	2	1234	1	1-3P/OV	I/I	CL/F		0.125	130	Y	EHT		806-1B
806-1C	2	1234	1	1-3P/OV	I/I	CL/F		0.125	130	Y	EHT		806-1C
806-1D	2	1234	1	1-3P/OV	I/I	CL/F		0.125	130	Y	EHT		806-1D
807-1A	2	1234	1	1-3P/OV	I/I	CL/F		0.125	130	Y	EHT		807-1A
808-1A	2	1234	1	1-3P/OV	I/I	CL/F		0.125	130	Y	EHT		808-1A
809-1A	2	1234	3	1-3P/OV	C/I	CL/F/L		0.250	40	Y	EHT		809-1A
810-1A	2	1234	3	1-3P/OV	C/I	CL		0.250	40	Y	EHT		810-1A
811-1A	2	1234	3	1-3P/OV	C/I	CL		0.250	40	Y	EHT		811-1A
812-1A	2	1234	3	1-3P/OV	C/I	CL/F		0.250	40	Y	EHT		812-1A
814-1A	2	1234	3	1-3P/OV	C/I	CL/F		0.250	40	Y	EHT		814-1A
815-1A	2	1234	3	1-3P/OV	C/I	CL/F		0.250	40	Y	EHT		815-1A
816-1A	2	1234	3	1-3P/OV	C/I	CL/F		0.250	40	Y	EHT		816-1A
817-1A	2	1234	3	1-3P/OV	C/I	CL/F		0.300	1	Y	EHT		817-1A
818-1A	2	1234	3	1-3P/OV	C/I	CL/F		0.300	1	Y	EHT		818-1A
819-1A		1234	3	1-3P/OV	C/I	CL/F/L					EHT		819-1A
819-1B		1234	3	1-3P/OV	C/I	CL/F					EHT		819-1B
820-1A	2	1234		1-3P/OV	C/S	CL/F			1	Y	EHT		820-1A
820-1B	2	1234		1-3P/OV	C/S	CL/F			1	Y	EHT		820-1B
820-1C	2	1234		1-3P/OV	C/S	CL/F				Y	EHT		820-1C
821-1A	1			1-3P/OV	C/S	CL/F	4		1	Y	EHT		821-1A
822-1A	2	1234		1-3P/OV	C/S	CL/F			1	Y	EHT		822-1A
822-1B	2	1234		1-3P/OV	C/S	CL/F			1	Y	EHT		822-1B
823-1A	1	1234		1-3P/OV	C/S	CL/F			1	Y	EHT		823-1A
824-1A	1	1234		1-3P/OV	C/S	CL/F			1	Y	EHT		824-1A
825-1A	1	1234		1-3P/OV	C/S	CL/F			1	Y	EHT		825-1A
826-1A	1	1234		1-3P/OV	C/S	CL/F			1	Y	EHT		826-1A
851-1A	2	1234	1	1-3P/OV	I/I	CL/F		0.125	130	Y	DNC	DNC	851-1A
852-1A	2	1234	1	1-3P/OV	I/I	CL/F		0.125	130	Y	DNC	DNC	852-1A
853-1A	2	1234	1	1-3P/OV	I/I	CL/F		0.125	130	Y	DNC	DNC	853-1A
854-1A	2	1234	1	1-3P/OV	I/I	CL/F		0.125	130	Y	DNC	DNC	854-1A
855-1A	2	1234	3			CL/F	1	0.250	40	Y	EHT	DNC	855-1A
856-1A	2	1234	3	1-3P/OV	I/I	CL/F		0.250	40	Y	EHT	DNC	856-1A
857-1A	2	1234	3	1-3P/OV	I/I	CL/F		0.250	40	Y	EHT	DNC	857-1A
858-1A	2	1234	3	1-3P/OV	I/I	CL/F		0.250	40	Y	EHT	DNC	858-1A
859-1A	2	1234	3	1-3P/OV	I/I	CL/F		0.250	40	Y	EHT	DNC	859-1A
859-1B	2	1234	3	1-3P/OV	I/I	CL/F		0.250	40	Y	EHT	DNC	859-1B
859-1C	2	1234	3	1-3P/OV	I/I	CL/F		0.250	40	Y	EHT	DNC	859-1C
859-1D	2	1234	3	1-3P/OV	I/I	CL/F		0.250	40	Y	EHT	DNC	859-1D

VST SYSTEM CONFIGURATION

RUN NO.	NO. OF SCRUBBER STAGES	S.T. HEADER CONFIG	NO.OF HOLD TANKS	M.E. SYSTEM CONFIG	M.E. WASH B/T	DE-WATER SYSTEM	OXID CONFIG FLAG	SPARGER HOLE DIAM., INCHES	NO. OF HOLES IN SPARGER	SPARGE TANK AGIT ATOR	ALK ADDN PT.	PRESCRUB ALKALI ADDITION POINT	RUN NO.
960-1A	2	1234	3	1-3P/OV	I/I	CL/F		0.250	40	Y	EHT	DNC	860-1A
861-1A	2	1234	3	1-3P/OV	I/I	CL/F		0.300	1		EHT	DNC	861-1A
862-1A	2	1234	3	1-3P/OV	I/I	CL/F		0.300	1			DNC	862-1A
863-1A		1234		1-3P/OV	I/I	CL/F					EHT		863-1A
864-1A		1234		1-3P/OV	I/I	CL/F					EHT		864-1A
865-1A		1234		1-3P/OV	I/I	CL/F					EHT		865-1A
866-1A		1234		1-3P/OV	I/I	CL/F					EHT		866-1A
867-1A	2	1234		1-3P/OV	I/S	CL/F			1	Y	EHT	DNC	867-1A

VST OPERATING CONDITIONS

RUN NO.	ALK TYPE	FLY ASH	MGO	PH CONTR POINT	PRESCRUB VENTURI PH CONTR POINT	GAS RATE ACFM	GAS VEL FPS	VEN LIQ RATE GPM	S.T. LIQ RATE GPM	VEN L/G GAL/ MACF	S.T. L/G GAL/ MACF	SOLID RECIRC NOM %	PRESCRUB VEN NOM % SOLIDS RECIRC	SOLIDS DISCH RANGE %	RUN NO.
801-1A	LS	Y	N		4.50	25000	6.7	400	1300	19.9	64.8	8.0	15.0		801-1A
802-1A	LS	Y	N		5.00	25000	6.7	400	1400	19.9	69.8	8.0	15.0		802-1A
803-1A	LS	Y	N		5.00	25000	6.7	600	1400	29.9	69.8	8.0	15.0		803-1A
804-1A	LS	Y	N		5.00	25000	6.7	600	1400	29.9	69.8		15.0		804-1A
805-1A	LS	Y	N		5.00	25000	6.7	600	1400	29.9	69.8		15.0		805-1A
806-1A	LS	Y	N		4.50	25000	6.7	600	1400	29.9	69.8		15.0		806-1A
806-1B	LS	Y	N		4.50	25000	6.7	600	1400	29.9	69.8		15.0		806-1B
806-1C	LS	Y	N		4.50	25000	6.7	600	1400	29.9	69.8		15.0		806-1C
806-1D	LS	Y	N		4.50	25000	6.7	600	1400	29.9	69.8		15.0		806-1D
807-1A	LS	Y	N		4.50	25000	6.7	600	1400	29.9	69.8		15.0		807-1A
808-1A	LS	Y	N		4.50	25000	6.7	600	1400	29.9	69.8		15.0		808-1A
809-1A	LS	N	N		4.50	25000	6.7	600	1400	29.9	69.8	7.8	15.0	72-88	809-1A
810-1A	LS	N	N		5.00	25000	6.7	600	1400	29.9	69.8	8.0	15.0	37-55	810-1A
811-1A	LS	N	N		5.50	25000	6.7	600	1400	29.9	69.8	8.0	15.0	39-52	811-1A
812-1A	LS	N	N		5.50	25000	6.7	600	1400	29.9	69.8	7.0	15.0	80.92	812-1A
814-1A	LS	N	N		5.50	25000	6.7	600	1400	29.9	69.8	8.4	15.0	84-92	814-1A
815-1A	LS	N	N		5.50	35000	9.4	600	1400	21.4	49.8	8.4	15.0	82-92	815-1A
816-1A	LS	N	N		5.50	35000	9.4	600	1400	21.4	49.8	7.6	15.0	81-91	816-1A
817-1A	LS	Y	N	5.50	5.50	35000	9.4	600	1400	21.4	49.8	8.8	15.0	82-89	817-1A
818-1A	LS	Y	N	5.50	5.50	35000	9.4	600	1600	21.4	57.0	9.6	15.0	82-89	818-1A
819-1A	LS	Y	N	5.50				600	1600			10.0		83-91	819-1A
819-1B	LS	Y	N					600	1600			15.2		82-89	819-1B
820-1A	LS	Y	Y		5.50	35000	9.4	600	1600	21.4	57.0	6.0	15.0	82-88	820-1A
820-1B	LS	Y	Y			35000	9.4	600	1600	21.4	57.0	8.2	15.0	78-86	820-1B
820-1C	LS	Y	Y			35000	9.4	600	1600	21.4	57.0	10.5	15.0	55-71	820-1C
821-1A	LS	Y	Y			35000	9.4	600		21.4			15.0		821-1A
822-1A	LS	Y	Y			35000	9.4	600	1600	21.4	57.0	8.0	15.0	80-90	822-1A
822-1B	LS	Y	Y			35000	9.4	600	1600	21.4	57.0	5.6	15.0	80-89	822-1B
823-1A	LS	Y	Y			18000	4.8	600	1600	41.5	110.8	13.3		79-87	823-1A
824-1A	LS	Y	Y			35000	9.4	600	1600	21.4	57.0	14.1		80-90	824-1A
825-1A	LS	Y	Y			18000	4.8	600	1600	41.5	110.8	14.7		82-88	825-1A
826-1A	LS	Y	Y			26500	7.1	600	1600	28.2	75.2	15.2		80-88	826-1A
851-1A	L	Y	N		4.50	25000	6.7	600	600	29.9	29.9	15.0	15.0	74-88	851-1A
852-1A	L	Y	N		4.50	25000	6.7	160	1400	8.0	69.8	15.0	15.0	65-80	852-1A
853-1A	L	Y	N		4.50	25000	6.7	600	1400	29.9	69.8	15.0	15.0	73-83	853-1A
854-1A	L	Y	N		5.20	25000	6.7	600	1400	29.9	69.8	15.0	15.0	75-83	854-1A
855-1A	L	N	N	8.00	4.50	25000	6.7	600	1400	29.9	69.8	7.3	15.0	62-88	855-1A
856-1A	L	N	N	8.00	5.00	25000	6.7	600	1400	29.9	69.8	7.8	15.0	75-90	856-1A
857-1A	L	N	N	8.00	5.50	25000	6.7	600	1400	29.9	69.8	7.8	15.0	70-86	857-1A
858-1A	L	N	N	8.00	5.50	25000	6.7	600	1400	29.9	69.8	15.2	8.0	72-90	858-1A
859-1A	L	N	N	8.00	5.50	25000	6.7	600	1400	29.9	69.8	7.2	15.0	64-83	859-1A
859-1B	L	N	N	8.00	5.50	25000	6.7	600	1400	29.9	69.8	7.6	15.0	69-86	859-1B
859-1C	L	N	N	8.00	5.50	25000	6.7	600	1400	29.9	69.8	7.3	15.0	64-77	859-1C
859-1D	L	N	N	8.00	5.50	25000	6.7	600	1400	29.9	69.8	7.0	15.0	52-57	859-1D

VST OPERATING CONDITIONS

RUN NO.	ALK TYPE	FLY ASH	MGO	PH CONTR POINT	PRESCRUB VENTURI PH CONTR POINT	GAS RATE ACFM	GAS VEL FPS	VEN LIQ RATE GPM	S.T. LIQ RATE GPM	VEN L/G GAL/ MACF	S.T. L/G GAL/ MACF	SOLID RECIRC NOM %	PRESCRUB VEN NOM % SOLIDS RECIRC	SOLIDS DISCH RANGE %	RUN NO.
860-1A	L	N	N	8.00	5.50	25000	6.7	600	1400	29.9	69.8	7.0	15.0	74-89	860-1A
861-1A	L	N	N	8.00	5.50	25000	6.7	600	1400	29.9	69.8	7.2	15.0	82-90	861-1A
862-1A	L	Y	N	8.00	5.50	35000	9.4	600	1400	21.4	49.8	17.3	15.0	82-89	862-1A
863-1A	L	Y	N	7.80				600	1600			10.4		80-89	863-1A
864-1A	L	Y	N	7.80		35000	9.4	600	1600	21.4	57.0	9.5		81-88	864-1A
865-1A	L	Y	N	7.80		35000	9.4	600	1600	21.4	57.0	10.1		76-84	865-1A
866-1A	L	Y	N	7.80		35000	9.4	600	1600	21.4	57.0	9.9		78-84	866-1A
867-1A	L	Y	N	7.80	5.50	35000	9.4	600	1600	21.4	57.0	11.8	15.0	83-88	867-1A

VST OPERATING CONDITIONS (CONTINUED)

RUN NO.	VEN D.P. IN. H2O	S.T. D.P. IN. H2O	M.E.SYSTEM D.P.RANGE IN.H2O	EFFLU RES TIME MIN	SPARGE TANK RESID TIME MIN.	VENTURI DESUP TANK RES TIME MIN.	SPARGE TANK LEVEL FEET	OXID AIR RATE SCFM	RUN NO.
801-1A	9.0			19.4	17.0	7.0	18.0	400	801-1A
802-1A	9.0			18.0	17.0	7.0	18.0	400	802-1A
803-1A	9.0			18.0	11.3	4.7	18.0	400	803-1A
804-1A	9.0			18.0	11.3	4.7	18.0	400	804-1A
805-1A	9.0			18.0	11.3	4.7	18.0	400	805-1A
806-1A	9.0			18.0	11.3	4.7	18.0	250	806-1A
806-1B	9.0			18.0	11.3	4.7	18.0	150	806-1B
806-1C	9.0			18.0	11.3	4.7	18.0	100	806-1C
806-1D	9.0			18.0	11.3	4.7	18.0	50	806-1D
807-1A	9.0			18.0	11.3	4.7	18.0		807-1A
808-1A	9.0			18.0	11.3	4.7	18.0	150	808-1A
809-1A	9.0	2.8	0.29-0.35	13.4	11.3	4.7	18.0	150	809-1A
810-1A	9.0	2.7	0.29-0.32	13.4	11.3	4.7	18.0	150	810-1A
811-1A	9.0	2.6	0.30-0.34	13.4	11.3	4.7	18.0	150	811-1A
812-1A	9.0	2.9	0.31-0.36	13.4	11.3		18.0	150	812-1A
814-1A	9.0	3.0	0.32-0.38	13.4	8.8	4.7	14.0	150	814-1A
815-1A	9.0	7.0	0.58-0.76	13.4	8.8	4.7	14.0	210	815-1A
816-1A	9.0	6.8	0.58-0.70	13.4	11.3	4.7	18.0	210	816-1A
817-1A	9.0	6.3	0.55-0.66	16.8	11.3	4.7	18.0	210	817-1A
818-1A	9.0	6.0	0.57-0.68	14.7	11.3	4.7	18.0	210	818-1A
819-1A	6.2	4.6	0.18-0.86	14.7					819-1A
819-1B	7.3	5.3	0.24-0.82	14.7					819-1B
820-1A	9.0		0.52-0.68	14.7	11.3	4.7	18.0	210	820-1A
820-1B	9.0		0.58-0.66	14.7	11.3	4.7	18.0	150	820-1B
820-1C	9.0		0.43-0.72	14.7	11.3	4.7	18.0		820-1C
821-1A	9.0			14.7	11.3	4.7	18.0	210	821-1A
822-1A	9.0		0.42-0.56	14.7	11.3	4.7	18.0	210	822-1A
822-1B	9.0		0.41-0.52	14.7	11.3	4.7	18.0	210	822-1B
823-1A	9.0		0.14-0.23	11.2			18.0	110	823-1A
824-1A	9.0		0.39-0.62	11.2			18.0	210	824-1A
825-1A	9.0		0.17-0.34	11.2			18.0	110	825-1A
826-1A	9.0		0.39-0.54	11.2			18.0	210	826-1A
851-1A	9.0	4.5	0.24-0.30		11.3	4.7	18.0	150	851-1A
852-1A	2.6	1.3	0.23-0.29		42.0	17.7	18.0	150	852-1A
853-1A	4.7	2.4	0.24-0.30		11.3	4.7	18.0	150	853-1A
854-1A	9.0	4.5	0.24-0.30		11.3	4.7	18.0	150	854-1A
855-1A	9.0	2.9	0.32-0.36	18.0	11.3	4.7	18.0	150	855-1A
856-1A	9.0	3.1	0.31-0.36	18.0	11.3	4.7	18.0	150	856-1A
857-1A	9.0	2.7	0.31-0.35	18.0	11.3	4.7	18.0	150	857-1A
858-1A	9.0	2.5	0.31-0.35	18.0	11.3	4.7	18.0	150	858-1A
859-1A	9.0	2.8	0.30-0.34	18.0	11.3	4.7	18.0	150	859-1A
859-1B	9.0	3.2	0.28-0.32	18.0	11.3	4.7	18.0	150	859-1B
859-1C	9.0	3.0	0.30-0.31	18.0	11.3	4.7	18.0	100	859-1C
859-1D	9.0	2.8	0.30-0.32	18.0	11.3	4.7	18.0		859-1D

VST OPERATING CONDITIONS (CONTINUED)

RUN NO.	VEN D.P. IN. H2O	S.T. D.P. IN. H2O	M.E.SYSTEM D.P.RANGE IN.H2O	EFFLU RES TIME MIN	SPARGE TANK RESID TIME MIN.	VENTURI DESUP TANK RES TIME MIN.	SPARGE TANK LEVEL FEET	OXID AIR RATE SCFM	RUN NO.
860-1A	9.0	2.8	0.30-0.33	12.6	11.3	4.7	18.0	150	860-1A
861-1A	9.0	3.2	0.27-0.32	18.0	11.3	4.7	18.0	150	861-1A
862-1A	9.0	6.4	0.55-0.64	18.0	11.3	4.7	18.0	210	862-1A
863-1A	5.6	5.0	0.06-0.61	14.7					863-1A
864-1A	9.0	6.3	0.48-0.68	14.7					864-1A
865-1A	9.0	6.0	0.56-0.78	14.7					865-1A
866-1A	9.0	7.4	0.61-0.75	14.7					866-1A
867-1A	9.0		0.66-0.82	14.7	8.8	4.7	14.0	210	867-1A

VST ANALYTICAL RUN SUMMARY (GASES)

RUN NO.	AVG SO2 IN PPM	MIN SO2 IN PPM	MAX SO2 IN PPM	AVG SO2 OUT PPM	MIN SO2 OUT PPM	MAX SO2 OUT PPM	AVG SO2 REM %	MIN SO2 REM %	MAX SO2 REM %	AVG MAKE PER PASS MMOL /L	MIN MAKE PER PASS MMOL /L	MAX MAKE PER PASS MMOL /L	AVG O2 IN %	MIN O2 IN %	MAX O2 IN %	AVG BOIL LOAD MEGA WATT	MIN BOIL LOAD MEGA WATT	MAX BOIL LOAD MEGA WATT
801-1A	3481	2780	3920	1177	820	1680	62	52	74	6.8	5.3	7.9	6.1	4.0	8.5	143	100	165
802-1A	3439	2780	4060	1142	630	1800	63	50	78	6.4	5.2	7.8	6.2	4.5	8.5	143	100	152
803-1A	3145	2640	3520	999	620	1900	64	37	77	5.4	3.3	6.4	6.6	5.3	7.8	131	93	164
804-1A	3221	2460	3840	861	500	1180	70	64	80	6.0	4.7	7.8	7.1	6.1	9.5	139	92	153
805-1A	3426	3000	4130	702	430	1000	77	69	84	7.0	5.7	8.4	6.3	3.8	7.7	147	125	151
806-1A	3340	3000	3840	816	660	1000	73	70	77	6.4	5.5	7.2	5.3	5.0	6.0	132	50	160
806-1B	2820	2520	3320	658	540	880	74	71	77	5.5	5.0	6.2	5.4	4.2	6.6	136	100	150
806-1C	3236	3000	3480	771	660	840	73	70	76	6.3	5.8	6.8	5.9	4.8	6.8	148	148	150
806-1D	3103	2700	3320	583	460	680	79	77	82	6.5	5.6	7.1	6.2	6.0	6.7	144	124	150
807-1A	3348	2920	3720	651	480	780	78	75	82	7.0	6.3	7.7	6.1	4.2	8.3	134	110	149
808-1A	2831	2640	3080	601	480	840	76	67	81	5.7	5.0	6.3	8.2	5.3	19.2	144	120	152
809-1A	2435	2060	2720	416	250	520	81	76	87	5.2	4.7	5.7	9.1	6.2	10.5	137	88	154
810-1A	2657	1840	3480	424	160	660	82	75	90	5.8	4.4	7.6	7.7	5.8	8.8	117	94	155
811-1A	2570	2200	3240	377	180	700	83	75	92	5.7	5.0	6.9	8.5	7.5	10.6	126	94	154
812-1A	2341	1960	2900	172	90	300	92	88	95	5.7	4.9	6.8	7.5	6.7	8.8	143	109	153
814-1A	2401	1920	2640	198	80	400	91	83	95	5.8	4.9	6.4	7.3	6.0	8.5	122	92	152
815-1A	2493	1860	3260	307	120	540	86	75	93	8.0	6.2	9.9	8.4	7.2	10.6	143	95	156
816-1A	2352	1980	2760	330	200	680	84	72	89	7.4	6.0	8.8	8.8	8.0	10.8	136	95	154
817-1A	2478	1920	3080	403	200	640	82	76	88	7.5	6.3	8.8	6.9	5.5	8.9	130	82	151
818-1A	2594	1840	3080	340	160	470	85	81	91	7.5	5.5	[illegible]	6.5	5.0	7.8	144	108	154
819-1A	2996	2320	3600	408	160	660	84	77	93				7.3	2.4	9.0	144	103	156
819-1B	2977	2680	3280	427	150	580	84	79	94				8.5	6.5	10.0	143	106	155
820-1A	2279	1280	3240	80	10	520	96	82	99	7.4	4.2	10.5	7.2	6.0	8.3	130	74	158
820-1B	2412	1760	2920	148	60	280	93	89	96	7.6	5.7	9.2	6.5	5.7	9.0	130	50	154
820-1C	2820	2320	3520	256	100	450	89	83	96	8.6	7.5	11.1	6.7	5.0	9.9	136	96	155
821-1A	1720	1720	1720	1340	1340	1340	14	14	14				6.0	6.0	6.0	126	126	126
822-1A	2758	2360	3300	259	40	600	89	80	98	8.3	7.3	9.8	6.6	5.6	10.0	147	96	158
822-1B	2378	1920	2840	220	80	320	89	86	95	7.2	6.2	8.4	7.4	5.0	10.0	139	102	158
823-1A	2507	2320	2960	139	20	240	93	91	99	4.1	3.8	4.7	8.2	6.4	10.0	112	102	138
824-1A	2627	2320	2840	285	120	540	87	78	95	7.8	6.7	8.9	7.3	6.0	10.0	138	96	154
825-1A	2458	1400	2860	135	30	300	93	87	99	4.0	2.4	4.7	8.5	6.0	10.0	139	93	154
826-1A	2731	2000	3240	272	90	560	89	79	95	6.2	4.9	7.4	8.8	7.0	10.0	139	94	157
851-1A	3267	2920	3840	676	440	960	77	72	83	11.1	10.6	12.3	5.9	5.2	6.7	131	50	152
852-1A	3328	2960	3720	904	540	1200	70	61	80	7.9	6.8	9.1	5.5	4.0	8.2	135	93	159
853-1A	3430	2640	3920	720	380	920	76	73	84	7.0	5.9	7.7	5.1	4.0	7.0	136	59	156
854-1A	3215	2680	3680	531	240	880	81	73	90	7.0	6.4	7.7	5.3	4.5	6.1	146	120	150
855-1A	2370	1480	3080	384	120	640	82	77	91	5.2	3.6	6.3	10.8	9.5	11.5	104	95	112
856-1A	2515	2240	2880	302	180	460	86	79	92	5.8	5.2	6.6	9.5	7.8	15.1	136	105	152
857-1A	2662	2480	2840	391	280	480	83	81	88	5.9	5.4	6.2	9.1	8.0	11.5	134	10	151
858-1A	2773	2360	3100	432	280	560	82	80	88	6.1	5.3	6.7	6.8	5.2	8.1	142	115	154
859-1A	2964	2760	3240	223	130	440	91	85	95	7.2	6.8	7.7	7.8	7.0	8.6	137	98	152
859-1B	2720	2560	3000	222	180	280	91	90	92	6.6	6.3	7.1	10.3	9.5	11.1	112	86	153
859-1C	2656	2320	3360	198	110	440	91	85	95	6.5	5.7	7.6	9.0	8.0	10.3	130	97	150
859-1D	2693	2480	3040	233	140	320	90	87	94	6.5	6.2	7.2	8.1	7.0	9.2	142	125	152

VST ANALYTICAL RUN SUMMARY (GASES)

RUN NO.	AVG SO2 IN PPM	MIN SO2 IN PPM	MAX SO2 IN PPM	AVG SO2 OUT PPM	MIN SO2 OUT PPM	MAX SO2 OUT PPM	AVG SO2 REM %	MIN SO2 REM %	MAX SO2 REM %	AVG MAKE PER PASS MMOL /L	MIN MAKE PER PASS MMOL /L	MAX MAKE PER PASS MMOL /L	AVG O2 IN %	MIN O2 IN %	MAX O2 IN %	AVG BOIL LOAD MEGA WATT	MIN BOIL LOAD MEGA WATT	MAX BOIL LOAD MEGA WATT
860-1A	2265	1960	2700	120	80	200	94	92	96	5.7	5.0	6.6	8.4	7.5	10.5	133	92	153
861-1A	2708	2080	3200	215	90	440	91	85	96	6.6	5.2	7.7	8.6	8.0	9.8	133	99	154
862-1A	2637	2080	3080	385	180	640	84	77	92	8.2	6.5	9.4	7.6	5.5	9.1	139	105	154
863-1A	2902	2160	4000	333	20	880	87	71	99				9.1	4.5	12.5	134	8	156
864-1A	2187	1600	2580	106	40	250	94	87	98	7.0	5.2	8.3				96	60	130
865-1A	2280	1400	3040	251	20	620	89	77	99	6.7	4.6	8.3				88	20	156
866-1A	2030	1160	3260	91	10	300	95	89	99	6.5	3.9	10.2	6.7	5.0	8.5	57	52	62
867-1A	2196	840	3320	261	10	680	88	76	99	6.4	2.8	9.2	9.0	8.5	10.0	66	65	68

RUN SUMMARY - LIQUID ANALYTICAL DATA

CONCENTRATIONS IN LIQUID, PPM

RUN NO.	ANALYTICAL POINT	PH			CA++			MG++			SO3=			SO4=			CL-		
		AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX
801-1A	1815	4.57	3.83	4.95	1254	1015	1567	615	420	723	65	11	814	2158	1819	2508	2359	1373	3168
	1816	5.76	5.43	6.12	842	278	1300	350	158	438	221	45	407	1575	768	2428	1118	265	1506
	1825	5.61	5.19	5.98	1075	810	1297	396	364	418	389	260	565	2016	1326	2468	1329	1107	1484
	1851	3.94	3.47	4.40	1483	1310	1667	673	634	722	410	147	588	2535	2106	2809	2773	2282	3257
802-1A	1815	4.96	4.30	5.33	1607	1280	2110	700	586	861	24	0	124	2159	1915	2633	3405	2481	4697
	1816	5.55	5.27	5.95	1308	1025	1610	486	401	609	197	33	508	2229	1904	2627	1979	1240	2747
	1825	5.29	4.20	5.95	1324	1015	1635	483	379	601	273	90	731	2282	1938	2740	1955	1329	2747
	1851	4.36	3.96	4.98	1876	1510	2315	702	503	873	462	45	882	2545	1807	3020	3494	2260	4697
803-1A	1815	5.09	4.66	5.79	2094	1725	2560	784	639	859	24	0	67	1904	1690	2195	4677	3998	5894
	1816	5.57	4.66	5.83	1674	1455	1940	549	455	589	264	90	1334	2257	1916	2914	2839	2659	3190
	1825				1683	1430	2080	534	443	585	333	67	1537	2277	1807	3004	2756	2397	3192
	1851	4.43	3.79	4.99	2264	1920	2695	784	659	853	311	22	531	2334	2076	2697	4728	3611	5827
804-1A	1815	5.07	4.79	5.40	2277	2010	2719	875	587	1011	22	0	90	1928	1711	2513	5360	4121	6204
	1816	5.79	5.12	5.99	1663	1520	1890	582	485	641	132	45	248	1974	1666	2424	3204	2836	3900
	1825				1669	1480	1870	576	519	637	173	79	316	1995	1713	2359	3150	2747	3877
	1851	4.43	3.86	4.75	2453	2190	2920	897	829	971	386	22	836	2298	1937	2788	5529	4742	6293
805-1A	1815	4.92	4.65	5.28	2231	1970	2495	1104	899	1251	13	0	67	1950	1789	2272	6025	5052	6470
	1816	6.06	5.69	6.20	663	374	1480	460	409	561	67	22	180	815	525	1883	1745	1196	2902
	1825				618	378	1385	450	389	565	80	22	226	744	444	1666	1687	1063	2792
	1851	4.36	4.04	4.68	2378	2150	2540	1112	1021	1243	334	45	565	2363	1949	3012	6202	5872	6603
806-1A	1815	4.62	4.48	4.79	2060	1920	2315	1224	1121	1325	16	0	33	2059	1931	2337	5970	5717	6381
	1816	6.16	6.06	6.25	392	335	450	393	367	419	93	33	226	733	434	901	1125	1019	1196
	1825				389	325	440	385	367	407	101	45	135	707	559	906	1070	975	1152
	1851	3.65	3.54	3.82	2203	2025	2490	1232	1111	1313	350	11	497	2330	2101	2573	6108	5850	6607
806-1B	1815	4.53	4.45	4.61	2202	1910	2440	1248	1145	1313	15	0	45	2042	1855	2194	6481	5694	7046
	1816	6.08	5.95	6.24	615	453	706	384	345	409	101	67	180	1423	968	1772	1114	975	1240
	1825				632	459	736	378	350	401	86	11	203	1543	1076	1949	1088	975	1258
	1851	3.76	3.58	4.00	2314	2015	2574	1267	1161	1331	250	0	520	2429	2012	2864	6580	5805	7179
806-1C	1815	4.49	4.31	4.57	1905	1880	1955	1170	1151	1207	15	11	22	2250	2012	2581	5538	5335	5761
	1816	6.01	5.97	6.15	560	360	694	315	213	365	101	56	135	1277	670	1702	970	930	1041
	1825				563	366	721	310	217	359	180	67	452	1192	506	1691	904	886	931
	1851	3.67	3.36	4.03	2044	1975	2135	1189	1167	1231	276	22	441	2604	2285	3020	5569	5406	5938
806-1D	1815	4.53	4.46	4.61	2027	1860	2140	1192	1151	1269	129	11	294	2277	969	2933	5273	4609	5539
	1816	6.16	6.12	6.20	308	293	335	397	367	453	116	90	158	684	548	813	993	930	1196
	1825				304	290	341	376	324	411	107	67	158	664	517	801	974	886	1240
	1851	4.23	4.11	4.36	2252	2100	2360	1204	1145	1273	698	260	949	2601	1522	3319	5469	5140	5717
807-1A	1815	4.48	4.41	4.57	1908	1810	2005	1020	899	1079	553	192	995	2931	2463	3622	4317	3900	4697
	1816	6.28	6.21	6.35	153	137	169	333	324	343	158	124	226	559	349	856	693	531	797
	1825				165	155	175	341	333	349	124	124	124	402	364	441	786	731	842
	1851	4.34	4.25	4.49	2030	1960	2125	1032	973	1101	990	554	1492	3063	2701	3966	4480	4010	4839

RUN SUMMARY - LIQUID ANALYTICAL DATA (CONTINUED)

RUN NO.	ANALYTICAL POINT	TOTAL IONS, PPM			PERCENT SULFATE SATURATION			PERCENT IONIC IMBALANCE		
		AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX
801-1A	1815	6552	5337	7375	99	88	126	2.6	-14.5	11.2
	1816	4163	1594	5864	75	30	126	4.4	-3.8	14.4
	1825	5270	4025	6177	101	63	128	-0.4	-12.1	8.3
	1851	8001	7559	8367	120	104	129	-5.7	-9.6	-1.1
802-1A	1815	8046	6493	9720	107	94	138	0.8	-12.3	9.5
	1816	6310	5249	7774	113	92	139	2.0	-12.5	13.4
	1825	6418	5127	7788	117	100	145	-0.2	-13.2	6.7
	1851	9208	7732	10725	133	103	152	-4.8	-14.9	8.1
803-1A	1815	9705	8738	11254	104	96	119	2.3	-11.9	7.8
	1816	7710	7012	9598	124	103	164	-0.5	-14.5	8.0
	1825	7703	6496	9956	126	98	175	-1.1	-14.6	5.4
	1851	10642	9101	11948	130	117	152	-2.6	-14.5	5.8
804-1A	1815	10715	9927	11897	105	93	136	1.2	-9.1	10.6
	1816	7691	7199	8692	107	88	133	0.5	-6.9	5.0
	1825	7703	7044	8734	109	90	133	0.6	-6.8	7.7
	1851	11808	10792	12800	127	111	157	-4.4	-9.9	0.4
805-1A	1815	11636	10079	12312	97	88	107	0.8	-3.6	4.6
	1816	3940	2861	7009	33	18	100	12.9	0.8	19.3
	1825	3762	2745	6650	29	16	86	12.4	4.4	18.3
	1851	12709	12246	12957	119	94	149	-5.3	-7.5	-2.6
806-1A	1815	11667	11300	12139	93	89	102	1.6	-0.3	4.6
	1816	2817	2649	3086	23	12	32	9.8	4.6	12.9
	1825	2731	2573	2904	22	16	31	11.8	6.9	16.6
	1851	12568	12128	13248	109	98	118	-2.9	-6.2	2.1
806-1B	1815	12344	11479	13042	95	91	101	-0.3	-4.9	4.6
	1816	3706	3122	4140	56	32	77	1.7	-9.3	9.0
	1825	3795	3031	4280	62	37	78	0.5	-9.0	10.3
	1851	13203	12304	13825	115	102	136	-4.3	-8.4	-0.4
806-1C	1815	11238	10906	11708	99	90	113	0.2	-3.9	2.9
	1816	3295	2507	3960	53	21	72	-0.7	-14.7	14.5
	1825	3217	2434	3914	50	24	73	1.5	-12.1	14.5
	1851	12053	11745	12798	117	103	139	-2.6	-8.1	0.4
806-1D	1815	11286	10224	12334	103	45	131	6.4	1.7	14.3
	1816	2574	2388	2823	18	16	22	11.1	7.3	14.0
	1825	2501	2278	2865	18	16	21	9.9	2.6	13.7
	1851	12611	11882	13379	123	74	156	-0.4	-2.9	5.2
807-1A	1815	11101	10336	11749	134	112	165	-2.1	-4.7	3.1
	1816	1969	1838	2148	9	6	14	6.3	-6.5	14.4
	1825	1894	1893	1896	8	7	9	13.3	8.7	17.9
	1851	11986	11661	12744	144	127	183	-7.4	-12.3	-4.7

RUN SUMMARY - LIQUID ANALYTICAL DATA

CONCENTRATIONS IN LIQUID, PPM

RUN NO.	ANALYTICAL POINT	PH			CA++			MG++			SO3=			SO4=			CL-		
		AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX
808-1A	1815	4.53	4.41	4.64	1566	1415	1715	1114	975	1197	19	0	45	2469	2227	2913	4257	3811	5052
	1816	6.33	6.33	6.33	220	220	220	266	266	266	45	45	45	931	931	931	310	310	310
	1825				210	210	210	266	266	266	45	45	45	973	973	973	310	310	310
	1851	3.56	3.32	3.92	1670	1500	1850	1104	967	1191	325	214	429	2807	2609	3338	4368	3955	5008
809-1A	1815	4.59	4.40	4.69	2830	2095	3489	1294	1087	1459	35	0	101	1834	1668	2004	7147	6204	8509
	1816	5.72	5.57	5.85	1916	1705	1950	711	611	789	98	33	217	2002	1792	2131	3562	3235	3811
	1825				1915	1740	2780	733	630	932	167	67	746	2113	1895	2508	3740	3279	6764
	1851	3.34	2.82	4.09	2857	2385	3799	1283	924	1544	149	0	443	2116	1775	2480	7001	6248	8331
810-1A	1815	5.09	4.83	5.73	1873	1140	2385	1141	977	1342	25	0	88	2171	1836	2652	4952	3990	6260
	1816	5.81	5.48	5.98	1455	1245	1775	639	544	719	88	13	191	2119	1860	2388	2653	2215	3545
	1825				1473	1275	1815	644	537	784	110	33	214	2133	1919	2424	2679	2082	3456
	1851	4.23	3.70	5.07	2039	1620	2584	1145	974	1324	280	113	814	2425	2023	2727	4983	3988	6337
811-1A	1815	5.50	5.25	5.74	1492	1125	1880	1032	567	1169	44	0	113	2551	2134	3074	3601	3190	4298
	1816	6.02	5.77	6.10	1262	1015	1690	594	312	757	108	56	169	2277	2032	2608	2149	1694	2481
	1825				1261	1040	1610	593	309	762	124	67	293	2276	1932	2737	2134	1817	2526
	1851	4.59	3.62	5.06	1558	1090	1955	1044	799	1249	473	243	938	2627	2141	3202	3649	3146	4343
812-1A	1815	5.58	5.15	6.23	1531	1320	1745	1137	1012	1389	67	5	237	2692	2483	2905	4056	3368	4564
	1816	5.92	5.39	6.05	1213	1042	1375	788	607	1012	109	67	147	2518	2300	2806	2528	1950	3057
	1825				1236	1022	1370	788	617	1014	148	67	294	2508	2290	2936	2564	1950	3146
	1851	4.84	4.43	5.40	1668	1430	1950	1133	892	1322	342	22	621	2872	2106	3407	4112	3545	4609
814-1A	1815	5.60	5.32	6.12	1524	1370	1790	1386	1027	1509	28	4	67	3000	2549	3348	4442	4121	5273
	1816	5.95	5.69	6.19	1281	1140	1440	866	612	1022	126	73	226	2561	2310	3062	2761	2570	3057
	1825	5.88	5.77	6.08	1241	1065	1375	855	682	992	127	79	248	2596	2311	2990	2720	2481	2947
	1851	4.57	4.04	4.95	1584	1385	1900	1340	1132	1464	332	158	633	3219	2607	3695	4439	4157	5273
815-1A	1815	5.69	4.94	6.33	2013	1445	2540	1614	1297	2059	42	5	90	2667	2310	2960	6060	4609	7622
	1816	5.83	5.62	6.04	1565	1240	1835	1095	929	1409	125	0	361	2540	2302	2934	3832	2925	4653
	1825	5.63	5.00	5.90	1609	1245	2035	1091	914	1352	137	45	280	2584	2316	3058	3818	2836	4857
	1851	4.61	3.85	5.74	2165	1660	2599	1560	1224	1904	434	45	746	2881	2019	3453	6010	4520	7401
816-1A	1815	5.50	5.25	6.17	2361	2150	2525	1950	1564	2274	26	11	45	2597	2404	2913	7651	6913	8420
	1816	5.74	5.50	5.87	1767	1610	1850	1173	974	1344	129	90	180	2460	2180	2773	4616	4254	4919
	1825	5.60	5.27	5.79	1790	1620	1975	1199	1074	1377	147	101	260	2422	1432	2890	4628	4254	4963
	1851	4.52	4.18	5.08	2475	2245	2705	1933	1764	2144	349	158	508	2861	2483	3298	7665	6825	8376
817-1A	1815	5.56	5.29	5.79	3332	2970	3560	1560	1374	1934	24	0	45	1945	1747	2109	8701	8251	9041
	1816	5.91	5.77	6.04	1970	1680	2180	831	719	947	92	45	226	1874	1525	2133	4391	3900	4830
	1825	5.78	5.57	6.00	1984	1725	2220	795	687	867	95	33	180	1948	1753	2797	4404	3767	4963
	1851	4.66	4.36	4.91	3560	3199	3939	1574	1339	1814	284	79	520	2418	1876	2877	8839	8509	9306
818-1A	1815	5.55	5.27	5.75	3616	2980	4300	1774	1499	1994	28	4	67	2010	1715	2174	9452	8243	10769
	1816	5.90	5.82	6.04	2071	1900	2340	903	812	989	100	39	158	1942	1765	2120	4938	4387	5406
	1825	5.76	5.62	5.98	2084	1895	2275	914	827	972	120	67	233	1931	1545	2172	4876	4405	5247
	1851	4.70	4.28	5.70	3836	3230	4500	1745	1399	1949	312	45	610	2447	1900	2883	9579	8154	10725

RUN SUMMARY - LIQUID ANALYTICAL DATA (CONTINUED)

RUN NO.	ANALYTICAL POINT	TOTAL IONS, PPM			PERCENT SULFATE SATURATION			PERCENT IONIC IMBALANCE		
		AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX
808-1A	1815	9786	9110	10615	98	92	109	5.9	1.1	14.2
	1816	1850	1850	1850	24	24	24	17.9	17.9	17.9
	1825	1880	1880	1880	24	24	24	14.1	14.1	14.1
	1851	10630	9896	11274	115	108	132	-1.6	-4.0	2.6
809-1A	1815	13318	11831	15322	96	83	116	5.1	-6.1	11.9
	1816	8307	7604	8683	106	95	113	5.6	-3.0	11.8
	1825	8787	7885	13357	113	101	132	4.4	-8.9	10.6
	1851	13587	12480	15963	111	101	127	3.4	-6.1	11.7
810-1A	1815	10321	8806	11987	95	73	109	3.8	-7.3	11.6
	1816	7055	6220	8208	103	93	115	6.0	-5.5	14.0
	1825	7143	6247	8396	104	93	117	5.6	-14.1	14.1
	1851	11037	9799	12701	111	91	131	1.7	-13.3	9.5
811-1A	1815	8868	7795	9458	102	87	146	5.2	-6.6	14.6
	1816	6493	5823	7020	105	90	146	4.0	-13.5	14.5
	1825	6489	5738	7519	106	88	135	3.8	-13.3	14.1
	1851	9513	8660	10417	106	92	125	-0.5	-14.1	13.4
812-1A	1815	9636	8940	10254	104	91	118	1.8	-11.3	12.0
	1816	7263	6204	8015	101	80	119	2.0	-6.2	9.1
	1825	7350	6269	8098	102	80	129	1.6	-4.9	7.1
	1851	10275	9213	11147	116	87	138	-1.6	-13.7	13.5
814-1A	1815	10576	9968	11274	104	92	122	4.3	-12.1	12.2
	1816	7715	7297	8274	102	86	131	3.5	-12.5	11.7
	1825	7657	7323	7993	102	85	124	1.8	-8.5	9.7
	1851	11113	10655	11841	115	103	137	-2.1	-10.7	6.3
815-1A	1815	12619	10820	14741	103	87	115	5.7	-14.8	14.8
	1816	9303	7925	10702	102	90	119	5.5	-0.5	13.2
	1825	9392	7939	11062	106	90	127	6.0	-4.4	14.8
	1851	13264	10595	15131	118	90	139	1.5	-10.5	13.4
816-1A	1815	14857	14013	15590	102	91	112	6.1	-9.2	14.6
	1816	10313	9436	10643	103	92	128	3.3	-3.4	10.7
	1825	10340	9136	10782	101	62	121	4.6	-1.2	14.8
	1851	15556	14578	16621	115	98	133	2.8	-2.6	7.7
817-1A	1815	15893	15018	16508	103	93	115	6.3	-1.7	14.6
	1816	9301	8480	10247	98	84	114	3.9	0.1	12.8
	1825	9376	8233	10335	103	93	151	1.5	-4.3	6.5
	1851	16982	16280	17659	131	103	145	3.4	-5.8	14.1
818-1A	1815	17273	15270	19170	106	91	120	9.1	5.2	14.4
	1816	10042	9219	10951	100	92	112	2.7	-2.3	8.2
	1825	10133	9423	10801	100	80	110	3.1	-1.8	8.2
	1851	18267	16206	19989	132	110	171	5.1	-2.9	10.6

RUN SUMMARY - LIQUID ANALYTICAL DATA

CONCENTRATIONS IN LIQUID, PPM

RUN NO.	ANALYTICAL POINT	PH			CA++			MG++			SO3=			SO4=			CL-		
		AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX
819-1A	1815	5.45	5.07	5.98	3521	2460	4509	2275	1659	2854	27	0	90	2183	1844	2484	10892	8509	13118
	1816	5.86	5.56	6.12	2202	1700	2975	1241	782	1644	110	45	203	2126	1738	2710	6150	5008	8110
	1825	5.68	5.32	6.02	2215	1670	3029	1239	719	1637	123	33	214	2157	1712	2623	6135	4875	8420
	1851	4.49	4.12	4.83	3722	2700	5110	2290	1664	2844	353	11	701	2497	1591	3037	10993	8863	13251
819-1B	1815	5.45	5.16	5.79	3475	2729	4490	2455	2324	2629	25	11	56	2446	2180	2576	10432	9395	11434
	1816	5.97	5.78	6.00	2356	1985	2825	1361	1212	1502	118	67	169	2352	2157	2619	6045	5495	6913
	1825	5.71	5.45	5.99	2338	2000	2749	1332	1182	1497	126	22	226	2416	2170	2795	5963	5362	6913
	1851	4.40	3.78	4.71	3704	3009	4509	2460	2194	2704	325	135	520	2845	2440	3184	10480	8863	11966
820-1A	1815	5.56	4.58	6.40	617	522	902	9422	8119	11539	50	11	226	35289	28208	43308	2765	1861	3634
	1816	6.05	5.40	6.89	569	156	786	5551	3879	6559	1435	554	4387	20131	13972	25842	1384	709	1684
	1825	6.79	6.79	6.79	569	274	930	4046	2929	5719	1228	260	3912	14624	8120	21396	1698	1019	2082
	1851	4.80	3.36	5.66	672	561	802	9315	7979	11119	429	45	1040	35350	31121	43672	2769	1817	3589
820-1B	1815	5.18	4.91	5.41	735	646	880	9425	8499	10239	950	33	1877	31530	28391	34224	4168	2836	6293
	1816	5.89	5.66	6.10	638	508	922	5566	4459	6369	1419	780	2259	18596	15815	20255	1830	1373	2836
	1825																		
	1851	5.00	4.69	5.91	761	698	912	9279	7599	10199	1584	407	2962	31232	27811	34078	4237	2747	6337
820-1C	1815	4.76	4.68	4.94	941	820	1214	9294	8159	10059	5583	4466	6672	26473	23859	30382	4435	3988	5052
	1816	5.87	5.66	6.03	613	234	974	5534	4989	6319	1559	972	2307	16871	14258	18843	2352	2041	2570
	1825	5.69	5.57	5.90	627	285	992	5459	4969	6039	1809	1108	3573	16765	13518	18894	2352	2041	2526
	1851	4.58	4.48	4.70	978	894	1204	9217	7939	10019	6275	4862	7633	26277	23982	29257	4753	4254	7223
821-1A	1815	4.00	4.00	4.00	674	674	674	9599	9599	9599	113	113	113	29452	29452	29452	6647	6647	6647
	1816																		
	1825	9.10	9.10	9.10	554	554	554	2980	2980	2980	283	283	283	11617	11617	11617	1553	1553	1553
	1851	5.46	5.46	5.46	724	724	724	9639	9639	9639	1130	1130	1130	29262	29262	29262	6603	6603	6603
822-1A	1815	5.15	4.30	5.60	713	588	832	10466	9460	11640	735	57	4207	31348	26732	36468	6871	3905	8165
	1816	5.74	5.60	6.00	663	482	900	6098	5180	7240	1684	226	3053	18700	14987	21813	3517	2751	4171
	1825	5.59	5.30	6.10	711	564	890	6181	4760	7320	2053	509	3279	18407	14677	21618	3512	2796	4171
	1851	4.86	4.00	5.50	744	614	842	10466	9460	11460	1148	226	2544	31340	26856	33511	6938	3994	8254
822-1B	1815	5.06	4.50	5.50	740	652	1044	9190	7680	10420	411	57	1018	28339	24184	30567	5752	5236	6346
	1816	5.53	5.40	6.30	782	532	1136	5985	4720	6720	3279	961	4184	17352	12516	19765	3324	2751	3816
	1825	5.40	5.20	6.10	859	586	1160	5870	4580	6720	3479	1300	4410	17026	12245	19823	3247	2574	3728
	1851	4.66	4.00	5.10	756	646	1112	9243	8360	10160	997	113	1809	28294	24166	32498	5825	5192	6346
823-1A	1815																		
	1816	5.25	4.94	5.70	881	640	1150	5870	5170	6450	5446	1561	8481	16628	12712	20248	2566	2263	2840
	1825	5.15	4.84	5.70	893	652	1128	5830	5020	6280	5503	1402	8029	16653	12506	19389	2545	2263	2840
	1851	4.85	4.40	5.30	952	630	1234	5902	5050	6470	5933	1742	8594	16833	13176	20019	2597	2263	2929
824-1A	1815																		
	1816	5.24	4.90	5.50	605	506	778	6125	5220	7540	5173	2431	9838	17495	14717	21323	2653	2263	2929
	1825	5.15	4.80	5.50	643	514	928	6116	5300	7420	5605	2940	10178	17127	13373	21773	2681	2352	2973
	1851	4.80	4.50	5.10	711	574	982	6237	5500	7460	5888	3506	10178	17421	13692	21934	2729	2352	3106

RUN SUMMARY - LIQUID ANALYTICAL DATA (CONTINUED)

RUN	ANALY TICAL	TOTAL IONS, PPM			PERCENT SULFATE SATURATION			PERCENT IONIC IMBALANCE		
NO.	POINT	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX
819-1A	1815	19448	15744	22874	101	80	120	7.2	-9.0	15.0
	1816	12129	10023	15325	99	85	119	0.6	-9.4	10.7
	1825	12170	9950	15591	101	80	122	0.6	-14.9	11.6
	1851	20426	17132	23914	118	83	155	5.6	-7.9	14.9
819-1B	1815	19356	17454	21396	108	97	130	12.0	7.7	15.0
	1816	12532	11459	13631	109	100	122	7.1	0.3	14.9
	1825	12469	11419	13712	112	104	128	6.1	-3.6	14.3
	1851	20371	17960	22305	130	117	139	10.7	1.6	14.9
820-1A	1815	48468	39465	59431	121	101	169	0.3	-10.8	12.8
	1816	29152	21471	36326	97	27	147	-1.6	-15.1	12.2
	1825	22279	16845	30027	89	46	116	-5.4	-14.8	8.8
	1851	48880	43687	58388	132	108	165	-1.8	-14.7	9.6
820-1B	1815	47119	42301	50069	125	113	153	3.0	-2.3	9.6
	1816	28168	23437	32213	101	85	148	3.9	-3.9	13.9
	1825									
	1851	47433	40267	51035	135	121	152	0.4	-8.7	8.6
820-1C	1815	47027	43439	49727	145	123	215	0.5	-10.0	7.5
	1816	27070	24320	29389	91	32	154	6.8	-2.2	13.2
	1825	27157	24360	29830	94	37	154	5.0	-1.2	9.6
	1851	47810	44861	51191	150	130	204	-2.7	-12.7	3.8
821-1A	1815	46785	46785	46785	112	112	112	3.7	3.7	3.7
	1816									
	1825	17074	17074	17074	91	91	91	-6.0	-6.0	-6.0
	1851	47635	47635	47635	119	119	119	1.8	1.8	1.8
822-1A	1815	50480	47010	57322	118	100	143	4.7	-2.7	14.2
	1816	30833	25051	34651	100	75	152	1.7	-12.7	10.2
	1825	31039	24780	34807	104	86	138	2.7	-5.3	15.0
	1851	50986	47518	55566	123	108	149	3.6	-4.5	12.9
822-1B	1815	44777	38897	48549	122	111	177	5.1	-2.9	11.6
	1816	30896	23535	35251	111	77	168	0.3	-11.6	8.9
	1825	30654	23474	35436	121	86	174	-0.1	-12.7	11.5
	1851	45463	41085	50798	124	102	193	3.9	-5.0	14.7
823-1A	1815									
	1816	31582	26603	34095	121	94	166	-3.9	-11.2	6.4
	1825	31611	27553	34305	123	99	169	-4.8	-13.2	4.2
	1851	32408	28500	35690	131	96	174	-6.1	-14.7	2.5
824-1A	1815									
	1816	32267	28542	37544	86	69	117	-5.3	-14.5	7.0
	1825	32386	28474	37818	90	58	127	-5.8	-14.4	10.1
	1851	33201	29025	38748	99	77	170	-5.8	-16.8	10.0

RUN SUMMARY - LIQUID ANALYTICAL DATA

CONCENTRATIONS IN LIQUID, PPM

RUN NO.	ANALYTICAL POINT	PH			CA++			MG++			SO3=			SO4=			CL-		
		AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	KIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX
825-1A	1815																		
	1816	5.45	5.10	6.00	655	538	792	6550	5230	7520	2618	905	4693	21049	17360	24282	3475	2973	4038
	1825	5.37	5.00	6.90	693	546	860	6404	5300	6990	2739	1131	4693	20909	18295	24267	3378	1420	3994
	1851	5.11	4.70	7.00	758	566	940	6613	5600	7760	3047	1538	5089	21215	17775	23904	3509	2751	3994
826-1A	1815																		
	1816	5.35	5.10	5.60	705	614	1040	6353	5270	8300	2917	565	4184	18978	16476	22226	3899	2973	4526
	1825	5.29	5.00	5.50	741	610	1046	6314	5530	7360	3030	509	4750	18993	15529	24059	3848	2973	4482
	1851	5.02	4.70	5.20	805	666	1152	6388	5000	7740	3380	735	5145	19047	16116	24729	3921	2929	4526
851-1A	1815	4.43	4.11	4.63	1447	1355	1570	1141	1040	1240	39	8	88	2502	2180	2852	3705	3461	3951
	1816	7.88	7.65	8.25	1152	1000	1360	704	632	790	76	22	112	1932	1450	2296	2383	2130	2531
	1825				1145	928	1278	740	667	788	222	64	336	1978	1672	2354	2355	2176	2529
	1851	3.60	3.30	4.03	1541	1300	1675	1167	1038	1378	194	8	336	2920	2469	3592	3802	3373	4128
852-1A	1815	5.63	5.04	6.11	1577	1405	1990	1203	1119	1323	22	0	56	2718	2369	3050	3961	3567	4564
	1816	7.83	6.57	8.28	867	747	1037	714	627	837	54	22	147	1374	1107	1593	2254	2038	2437
	1825				848	632	1075	747	599	851	277	56	520	1435	1092	1775	2264	2038	2437
	1851	4.28	3.87	4.56	1971	1650	2425	1306	1229	1395	980	723	1379	3102	2761	3492	4487	4343	4742
853-1A	1815	4.80	4.19	5.37	1569	1115	1790	1355	1119	1479	35	0	316	2683	2285	2899	4190	3767	4675
	1816	8.03	7.57	8.29	1243	1065	1440	865	667	1011	62	32	124	1933	1526	2421	2671	2481	3102
	1825	5.48	5.16	6.02	1206	1005	1415	904	739	1035	228	22	429	2132	1602	2701	2609	2399	2947
	1851	4.92	3.37	5.65	1744	1080	2095	1349	1079	1463	313	22	995	2997	2280	3418	4198	3722	4764
854-1	1815	5.05	4.62	5.50	1664	1345	1950	1314	1071	1507	33	0	192	2598	2189	2917	4325	3456	4963
	1816	8.02	7.70	8.21	1086	766	1445	891	721	973	58	0	147	1557	1077	2305	2860	2082	3057
	1825	5.64	5.31	6.12	1042	800	1460	925	755	1015	229	45	474	1605	1152	2342	2835	2082	3057
	1851	3.82	3.03	4.50	1819	1420	2210	1337	955	1559	384	22	1007	3075	2681	3805	4456	3412	4919
855-1A	1815	4.71	4.44	5.14	1046	884	1285	304	236	372	24	0	56	1986	1720	2331	989	801	1418
	1816	8.11	7.99	8.30	853	795	922	78	44	121	35	11	64	1515	1356	1647	461	244	621
	1825	5.61	5.31	6.21	917	842	1026	176	71	419	217	27	475	1728	1509	1982	569	244	976
	1851	3.60	3.32	4.36	1202	1140	1280	290	249	375	314	226	386	2088	1875	2545	1088	826	1420
856-1A	1815	5.10	4.37	5.50	1277	964	1605	565	425	766	91	11	304	1952	1628	2608	2063	1373	3106
	1816	8.07	7.82	8.30	958	830	1160	224	127	369	57	11	102	1629	1461	1852	880	531	1487
	1825	5.41	5.25	5.68	964	832	1130	272	141	424	233	113	392	1763	1448	2106	837	531	1397
	1851	3.64	3.05	4.64	1455	1207	1638	565	446	760	448	57	937	2113	1692	2333	2111	1462	3106
857-1A	1815	5.38	4.71	6.21	1782	1582	2005	838	737	924	64	11	158	1987	1836	2272	3627	2969	4210
	1816	8.03	7.83	8.28	1210	1042	1345	446	365	519	88	22	147	1761	1627	1970	1840	1462	2348
	1825	5.54	5.11	6.70	1219	1042	1330	466	385	528	332	67	497	1823	1657	2022	1815	1396	2082
	1851	4.27	3.45	6.62	1953	1710	2195	863	735	947	505	67	927	2116	1420	2563	3701	3102	4210
858-1A	1815	5.51	5.33	5.75	2443	1895	3354	1063	805	1227	20	0	45	2057	1767	2567	5146	4165	6736
	1816	7.98	6.90	8.45	984	845	1117	300	257	350	47	22	85	1595	1151	1939	1243	1019	1373
	1825	5.40	5.02	5.66	988	850	1115	332	285	399	212	49	452	1710	1264	1954	1259	1063	1471
	1851	3.64	2.98	4.41	2611	2060	3400	1064	803	1214	427	316	576	2144	1764	2434	5270	4165	7312

RUN SUMMARY - LIQUID ANALYTICAL DATA (CONTINUED)

RUN NO.	ANALYTICAL POINT	TOTAL IONS, PPM			PERCENT SULFATE SATURATION			PERCENT IONIC IMBALANCE		
		AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX
825-1A	1815									
	1816	34566	29809	37911	104	89	130	-4.1	-11.4	5.4
	1825	34350	31209	37432	111	91	139	-5.3	-14.9	2.6
	1851	35364	32039	38967	119	98	154	-4.9	-11.9	7.0
826-1A	1815									
	1816	33097	28178	37121	105	84	157	-2.3	-17.5	14.0
	1825	33169	28345	37205	110	90	171	-2.7	-18.3	8.1
	1851	33790	28213	38984	119	93	188	-3.4	-13.8	6.2
851-1A	1815	9066	8851	9513	94	90	102	9.5	5.7	14.3
	1816	6367	5966	6861	81	59	107	8.4	1.5	10.7
	1825	6566	6117	7215	81	60	98	7.4	4.9	9.5
	1851	9853	9172	10867	111	98	128	4.3	0.5	6.4
852-1A	1815	9759	9209	10430	104	90	117	9.7	0.9	14.7
	1816	5404	4892	6023	49	43	58	12.2	7.9	18.0
	1825	5712	4763	6516	50	33	71	6.9	-9.3	14.3
	1851	12138	11073	12939	130	103	159	-0.1	-8.5	3.7
853-1A	1815	10117	9291	10727	97	82	105	12.3	5.1	18.8
	1816	6921	6203	8064	77	56	98	15.1	8.6	19.4
	1825	7224	6439	8416	81	58	101	11.2	5.5	17.2
	1851	10878	10064	11780	114	85	132	8.9	-10.2	15.6
854-1A	1815	10213	8687	11364	99	82	118	11.8	2.2	15.2
	1816	6597	5186	7814	58	35	96	13.3	9.5	16.5
	1825	6781	5482	8126	57	37	97	10.4	2.0	19.2
	1851	11364	9499	12579	121	104	165	5.3	-8.6	13.6
855-1A	1815	4420	3779	4990	106	91	123	12.3	-1.1	14.5
	1816	2980	2707	3321	100	97	107	9.5	0.0	15.6
	1825	3648	2915	4320	102	88	113	5.9	-4.8	13.9
	1851	5057	4726	5780	118	113	129	5.2	-9.2	12.4
856-1A	1815	6036	4888	7511	94	80	126	10.6	1.7	14.8
	1816	3798	3129	4780	94	89	113	11.4	6.1	18.0
	1825	4115	3316	5102	96	84	110	8.1	1.4	14.2
	1851	6781	5900	8094	108	87	121	6.1	-4.0	15.8
857-1A	1815	8404	7546	9180	98	90	110	9.9	-1.4	14.2
	1816	5408	4843	5978	91	83	100	8.4	-8.5	13.6
	1825	5721	4950	6170	93	84	102	3.7	-15.2	11.9
	1851	9244	7692	10451	107	75	132	6.4	-4.8	13.7
858-1A	1815	10854	9350	13232	107	96	131	11.6	4.8	14.4
	1816	4232	3576	4846	86	60	103	8.5	-1.6	14.1
	1825	4566	3901	5135	89	62	102	3.2	-5.3	11.2
	1851	11642	9984	13838	115	101	136	8.0	-2.5	13.5

RUN SUMMARY - LIQUID ANALYTICAL DATA

CONCENTRATIONS IN LIQUID, PPM

RUN NO.	ANALYTICAL POINT	PH			CA++			MG++			SO3=			SO4=			CL-		
		AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX
859-1A	1815	5.49	5.29	5.66	2116	1910	2345	957	772	1112	99	67	192	1856	1695	2057	4537	4298	4875
	1816	8.10	8.00	8.29	1350	1217	1507	569	473	656	78	45	101	1222	880	1698	2785	2681	2925
	1825				1340	1170	1567	588	511	661	194	67	429	1380	903	2123	2745	2614	2880
	1851	4.58	4.37	4.77	2332	2110	2584	936	797	1019	837	610	1062	2127	1980	2369	4517	4165	4875
859-1B	1815	5.49	5.12	5.65	2007	1830	2160	1045	964	1122	33	0	56	2140	1982	2239	4390	4165	4609
	1816	8.01	7.78	8.32	1441	1335	1552	595	509	670	63	11	128	1772	1670	1932	2566	2348	2836
	1825				1466	1430	1547	614	582	664	304	248	361	1880	1722	2052	2516	2348	2614
	1851	4.02	3.17	4.64	2180	1855	2400	1016	909	1129	514	226	757	2339	2092	2496	4312	3722	4697
859-1C	1815	5.60	5.23	6.41	2317	1905	2825	944	867	1009	87	16	180	1912	1712	2096	4872	4099	5938
	1816	8.01	7.70	8.19	1437	1382	1500	602	529	679	51	22	90	1715	1562	1889	2731	2481	3102
	1825				1424	1350	1477	602	528	697	256	4	497	1771	1459	2219	2687	2508	2969
	1851	4.56	4.44	4.68	2497	2175	2925	948	849	1044	922	746	1108	1995	1760	2292	4991	4099	6160
859-1D	1815	5.36	4.89	5.58	2265	2125	2560	1013	824	1064	90	45	113	2126	1986	2351	4877	4742	5052
	1816	7.93	7.42	8.12	1229	1042	1445	594	550	668	54	33	79	946	606	1420	2954	2836	3146
	1825				1203	1030	1517	576	474	622	86	33	180	881	560	1751	2912	2809	3102
	1851	4.60	4.41	4.75	2324	2100	2480	1028	919	1084	762	678	859	2271	2004	2543	4930	4786	5074
860-1A	1815	5.52	5.36	5.75	2799	2310	3479	1145	1007	1249	22	0	45	1852	1721	2109	6515	5406	7888
	1816	8.04	7.90	8.21	1489	1230	1725	596	483	682	39	11	67	1317	1111	1565	3060	2437	3545
	1825				1507	1277	1637	620	529	702	49	11	79	1374	1162	1654	3063	2419	3678
	1851	3.78	3.40	4.35	2811	2210	3660	1134	974	1259	265	169	395	2097	1883	2473	6417	5052	7977
861-1A	1815	5.49	5.20	5.98	2689	2355	3270	1833	1564	2054	38	11	90	2227	1960	2379	8150	6958	8996
	1816	7.83	6.79	8.20	1791	1420	2000	1030	964	1107	91	22	124	1972	1445	2492	4512	4121	4830
	1825	5.86	5.12	6.37	1789	1570	1970	1082	967	1224	116	67	158	2131	1508	2690	4513	4033	4830
	1851	3.26	2.89	4.29	2825	2340	3695	1845	1579	2029	265	33	542	2504	1146	3042	8163	7418	9041
862-1A	1815	5.54	5.17	5.71	3244	2739	3960	1877	1354	2259	29	0	67	2255	1963	2660	9031	7489	10858
	1816	8.01	7.66	8.36	1484	1195	1755	687	499	954	85	22	135	1782	1468	2107	3191	2526	4033
	1825	5.78	5.17	7.46	1461	1185	1690	716	514	994	181	33	339	1890	1520	2356	3153	2481	4033
	1851	4.30	4.00	4.52	3456	2970	4399	1884	1449	2209	455	203	678	2632	2266	2955	9140	7622	11389
863-1A	1815	5.60	4.90	7.04	3003	2600	3850	2342	1849	2949	36	4	237	2579	2161	2925	10013	8863	12763
	1816	7.81	5.95	8.16	1962	1680	2380	1310	1157	1492	80	22	147	2398	1973	4088	5362	4254	6390
	1825	4.89	3.79	5.31	2002	1675	2450	1315	1149	1569	353	56	882	2638	1990	5043	5296	3825	6301
	1851	4.24	3.40	4.89	3207	2580	4339	2339	1459	2884	471	22	1368	2929	2052	5850	10072	9041	12187
864-1A	1815	5.59	5.41	5.78	3214	2920	3629	2442	2224	2630	26	8	36	2499	2305	2667	10920	10193	11538
	1816	7.84	7.53	8.16	2196	1990	2355	1420	1332	1484	84	22	167	2332	2075	2534	5937	5503	6257
	1825				2148	2010	2490	1405	1320	1474	208	56	441	2439	2137	2732	5929	5717	6204
	1851	4.38	3.92	5.91	3328	2879	3649	2439	2239	2640	340	56	576	2793	2592	3091	11059	10370	11715
865-1A	1815	5.58	5.41	5.90	2667	2340	3199	1609	1444	1854	66	11	169	2195	2109	2281	8029	7268	9041
	1816	7.82	7.45	8.14	1807	1620	2070	993	902	1107	91	33	203	2116	2022	2291	4451	3722	4875
	1825				1840	1575	2110	997	902	1102	359	22	735	2314	1867	2598	4449	3767	4875
	1851	4.53	4.08	5.66	2869	2230	3489	1599	1469	1834	544	11	1029	2509	2234	2800	8087	7090	9138

RUN SUMMARY - LIQUID ANALYTICAL DATA (CONTINUED)

RUN NO.	ANALYTICAL POINT	TOTAL IONS, PPM AVG	TOTAL IONS, PPM MIN	TOTAL IONS, PPM MAX	PERCENT SULFATE SATURATION AVG	PERCENT SULFATE SATURATION MIN	PERCENT SULFATE SATURATION MAX	PERCENT IONIC IMBALANCE AVG	PERCENT IONIC IMBALANCE MIN	PERCENT IONIC IMBALANCE MAX
859-1A	1815	9695	9422	10152	95	88	102	10.3	0.9	14.9
	1816	6072	5602	6794	63	47	89	9.0	-0.6	13.9
	1825	6317	5452	7330	69	46	104	5.5	-15.0	13.1
	1851	10885	10594	11168	114	105	130	2.6	-8.6	12.2
859-1B	1815	9777	9380	10308	102	97	108	11.8	8.4	14.6
	1816	6535	6087	7074	90	86	98	10.8	7.5	12.5
	1825	6872	6493	7145	95	89	105	7.2	1.6	13.0
	1851	10523	9442	10969	117	102	126	7.3	3.7	14.3
859-1C	1815	10275	9265	11703	102	96	112	9.7	5.7	14.6
	1816	6619	6427	6992	87	80	95	8.1	2.0	14.8
	1825	6826	6544	7168	89	72	112	3.6	-6.0	9.8
	1851	11505	10531	12986	110	104	118	1.3	-7.8	9.4
859-1D	1815	10520	10230	10998	110	98	126	8.8	7.4	11.4
	1816	5863	5234	6805	47	28	71	8.0	0.3	10.4
	1825	5744	5287	7184	43	30	90	7.1	-0.6	12.9
	1851	11462	11090	11972	117	103	136	0.1	-5.9	4.6
860-1A	1815	12496	10740	14508	101	93	109	7.0	-2.9	11.4
	1816	6593	5572	7320	69	57	86	9.5	5.8	14.6
	1825	6706	5779	7703	72	59	91	10.4	4.0	14.3
	1851	12884	10818	15440	114	105	128	3.3	-5.7	5.9
861-1A	1815	15187	13352	16712	97	93	108	5.6	-1.8	12.8
	1816	9532	8282	10454	90	60	120	4.8	-4.3	11.2
	1825	9768	8533	10711	94	69	122	4.9	-2.8	11.4
	1851	15838	14698	17785	111	57	143	3.8	-6.0	13.1
862-1A	1815	16746	14320	19473	109	94	131	7.7	2.5	12.2
	1816	7350	6066	8910	87	74	98	4.0	-3.8	9.4
	1825	7522	6199	9540	90	75	106	2.4	-2.3	11.0
	1851	17888	15632	21198	131	107	144	4.5	1.4	11.2
863-1A	1815	18556	16467	21622	107	89	130	7.0	-11.9	14.8
	1816	11425	10232	14200	102	80	175	6.2	-13.7	13.9
	1825	11919	10361	14380	112	84	214	2.7	-8.4	19.4
	1851	19610	17787	22734	126	91	240	4.1	-9.4	14.8
864-1A	1815	19713	18544	20658	106	95	116	5.7	2.0	14.0
	1816	12286	11495	12722	102	90	112	8.1	4.7	13.9
	1825	12428	11905	13006	106	96	123	4.3	1.4	9.4
	1851	20580	19553	21457	121	108	137	2.5	-1.9	9.0
865-1A	1815	15090	13989	16310	102	95	116	3.2	-8.9	13.0
	1816	9733	8799	10419	98	91	108	5.2	-4.2	12.6
	1825	10225	9193	11088	107	91	118	0.1	-8.1	9.5
	1851	16147	14619	17611	120	103	137	-0.6	-11.8	11.0

RUN SUMMARY - LIQUID ANALYTICAL DATA

CONCENTRATIONS IN LIQUID, PPM

RUN NO.	ANALYTICAL POINT	PH			CA++			MG++			SO3=			SO4=			CL-		
		AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX
866-1A	1815	5.56	4.95	7.75	2330	2010	2980	1701	1549	1884	51	11	214	2364	2103	2650	8077	7179	9484
	1816	7.84	7.40	9.02	1647	1445	2050	882	742	969	83	33	147	2004	1732	2293	4259	4077	4609
	1825				1576	1400	1775	876	732	977	164	33	508	2046	1731	2476	4256	4077	4520
	1851	4.56	4.00	4.90	2478	2070	3039	1674	1484	1904	467	40	1402	2730	2204	3387	8058	7090	9306
867-1A	1815	5.55	5.40	5.90	1768	1540	2245	1800	1539	2174	41	0	90	2706	2459	3190	6692	6027	7241
	1816	7.82	6.77	9.12	1240	1080	1455	905	814	992	78	45	124	2218	2074	2413	3367	3013	3634
	1825				1238	1085	1410	909	772	999	274	67	689	2320	1978	2505	3357	3013	3678
	1851	4.38	4.04	4.68	1854	1620	2050	1793	1579	2019	373	33	768	3094	2710	3388	6797	6204	7090

RUN SUMMARY - LIQUID ANALYTICAL DATA (CONTINUED)

RUN NO.	ANALYTICAL POINT	TOTAL IONS, PPM			PERCENT SULFATE SATURATION			PERCENT IONIC IMBALANCE		
		AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX
866-1A	1815	15003	13917	16672	98	90	109	-2.4	-12.4	9.5
	1816	9185	8461	10087	92	85	102	0.9	-5.1	10.5
	1825	9214	8381	10118	92	85	105	-3.6	-12.5	3.9
	1851	15910	14791	16991	117	100	142	-6.9	-13.5	5.2
867-1A	1815	13473	12390	14814	91	84	102	2.2	-2.1	10.8
	1816	8048	7409	8590	86	81	100	0.9	-5.1	5.8
	1825	8342	7561	9163	89	78	98	-3.5	-13.0	4.5
	1851	14384	13427	15098	106	97	114	-3.8	-9.1	1.6

RUN SUMMARY - SOLIDS ANALYTICAL DATA

CONCENTRATIONS IN SOLIDS, WT %

RUN NO.	ANALYTICAL POINT	CO2 AVG	CO2 MIN	CO2 MAX	SO2 AVG	SO2 MIN	SO2 MAX	SO3 AVG	SO3 MIN	SO3 MAX	CAO AVG	CAO MIN	CAO MAX	ACID INSOLUBLES AVG	ACID INSOLUBLES MIN	ACID INSOLUBLES MAX	SOLIDS IN SLURRY, WT % AVG	SOLIDS IN SLURRY, WT % MIN	SOLIDS IN SLURRY, WT % MAX
801-1A	1815	0.68	0.02	2.80	1.74	0.18	16.28	14.61	2.17	40.09	13.12	4.20	36.68	7.95	5.62	10.00	14.9	10.3	22.6
	1816	5.00	1.87	9.13	32.69	7.60	39.45	7.24	0.97	46.43	41.77	36.47	44.01	0.22	0.16	0.31	5.9	3.7	10.0
802-1A	1815	1.72	0.16	6.32	0.55	0.00	1.75	15.54	5.02	29.48	13.82	6.85	24.23	5.70	0.54	10.08	14.6	10.9	16.8
	1816	9.03	2.69	15.28	28.14	19.54	35.47	7.41	2.14	12.97	42.17	36.86	45.41	0.25	0.11	0.57	5.9	4.6	8.0
803-1A	1815	1.54	0.44	4.07	0.56	0.18	1.09	16.02	9.46	22.40	13.64	8.09	18.80	7.28	4.31	10.46	14.9	11.3	17.8
	1816	8.87	1.49	13.39	27.13	19.90	32.57	7.33	3.05	17.19	41.87	37.72	44.44	0.23	0.15	0.27	5.1	2.4	7.1
804-1A	1815	1.17	0.10	1.92	0.42	0.00	0.98	16.24	5.52	29.57	13.64	5.90	23.38	7.78	6.15	11.11	14.9	12.0	17.0
	1816	9.91	5.61	16.50	28.26	22.26	31.85	6.32	1.38	11.44	42.94	40.28	46.32	0.46	0.24	0.89	7.4	5.9	10.0
805-1A	1815	1.33	0.33	3.11	0.30	0.01	1.44	18.55	12.76	24.05	15.51	10.18	19.06	6.45	5.46	8.44	14.4	10.9	16.7
	1816	11.11	6.12	15.89	28.36	23.16	35.77	4.68	1.46	13.75	43.59	40.96	46.17	0.61	0.22	1.23	14.5	7.4	17.6
806-1A	1815	0.64	0.22	0.90	0.21	0.01	0.53	21.00	14.97	33.23	15.54	10.95	24.08	7.03	5.24	8.82	14.6	13.2	15.8
	1816	6.80	4.78	9.90	33.54	28.95	36.91	4.27	0.15	8.97	42.30	41.22	43.63	0.48	0.33	0.62	15.2	14.1	16.0
806-1B	1815	0.43	0.22	0.66	0.28	0.15	0.36	17.87	8.78	30.59	13.12	6.98	21.34	7.15	5.95	8.35	15.0	13.0	16.4
	1816	6.22	5.50	6.86	32.98	24.13	36.19	8.49	4.21	20.31	43.07	41.42	44.15	0.66	0.64	0.68	14.5	13.9	15.5
806-1C	1815	0.30	0.05	0.53	0.51	0.01	1.27	21.44	15.37	27.81	16.01	11.63	20.25	6.35	5.74	6.95	14.7	14.0	15.9
	1816	6.54	4.34	9.65	32.09	29.46	35.76	8.55	4.07	12.41	43.09	41.62	45.12	0.25	0.04	0.45	14.2	13.3	15.0
806-1D	1815	1.18	0.76	1.87	6.57	3.07	11.37	16.32	13.76	20.05	19.13	15.16	22.00	3.70	2.53	4.87	14.4	13.6	16.3
	1816	8.52	7.72	9.94	31.88	27.14	35.47	6.58	2.79	11.20	44.16	41.83	45.66	0.43	0.16	0.69	15.9	15.4	16.5
807-1A	1815	1.86	1.10	2.91	22.93	21.29	25.29	5.33	2.20	10.75	26.50	24.21	27.96	4.85	4.20	5.43	14.6	12.9	15.8
	1816	8.63	7.09	11.14	33.74	31.82	36.90	2.26	0.31	4.42	42.29	40.94	44.08	0.55	0.52	0.59	17.1	16.0	17.8

RUN SUMMARY - SOLIDS ANALYTICAL DATA (CONTINUED)

RUN NO.	ANALYTICAL POINT	PERCENT SULFITE OXIDATION			STOICHIOMETRIC RATIO			PERCENT IONIC IMBALANCE		
		AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX
801-1A	1815	87.6	22.1	98.8	1.10	1.00	1.66	3.2	-7.6	8.4
	1816	14.6	2.0	83.0	1.19	1.06	1.40	4.1	-3.6	8.5
802-1A	1815	94.9	78.8	100.0	1.23	1.01	1.85	1.9	-7.9	7.9
	1816	17.4	6.1	32.7	1.40	1.10	1.84	2.0	-4.1	8.2
803-1A	1815	95.8	91.7	98.2	1.17	1.05	1.50	-0.2	-7.3	7.3
	1816	17.6	7.4	34.8	1.41	1.05	1.72	4.0	-4.0	7.6
804-1A	1815	96.5	86.0	100.0	1.14	1.01	1.31	2.9	-6.7	7.8
	1816	15.1	4.1	24.5	1.44	1.22	1.88	2.7	-2.9	7.1
805-1A	1815	97.9	90.1	99.9	1.14	1.03	1.37	3.5	-2.3	7.6
	1816	11.6	4.3	32.2	1.52	1.23	1.95	3.0	-6.7	7.9
806-1A	1815	98.6	96.8	100.0	1.06	1.02	1.07	-1.0	-4.3	3.0
	1816	9.3	0.3	19.9	1.27	1.19	1.40	3.1	-2.7	7.6
806-1B	1815	97.6	95.8	99.3	1.06	1.01	1.13	-1.5	-5.6	3.2
	1816	17.1	8.5	40.2	1.23	1.20	1.25	0.7	-1.3	3.9
806-1C	1815	96.9	91.4	99.9	1.03	1.00	1.05	0.9	-4.4	3.8
	1816	17.3	9.5	25.2	1.25	1.15	1.41	1.5	-1.9	7.8
806-1D	1815	67.5	50.1	83.7	1.09	1.05	1.14	2.3	-2.1	5.0
	1816	14.2	6.2	22.5	1.33	1.29	1.40	1.8	-1.1	5.8
807-1A	1815	15.4	6.5	28.4	1.10	1.06	1.16	1.3	-5.8	6.5
	1816	5.0	0.7	9.3	1.36	1.27	1.49	0.4	-4.4	5.4

RUN SUMMARY - SOLIDS ANALYTICAL DATA

CONCENTRATIONS IN SOLIDS, WT %

RUN NO.	ANALYTICAL POINT	CO2 AVG	CO2 MIN	CO2 MAX	SO2 AVG	SO2 MIN	SO2 MAX	SO3 AVG	SO3 MIN	SO3 MAX	CAO AVG	CAO MIN	CAO MAX	ACID INSOLUBLES AVG	ACID INSOLUBLES MIN	ACID INSOLUBLES MAX	SOLIDS IN SLURRY, WT % AVG	SOLIDS IN SLURRY, WT % MIN	SOLIDS IN SLURRY, WT % MAX
808-1A	1815	0.26	0.05	0.52	0.40	0.17	0.72	25.62	14.92	30.49	19.29	11.46	23.83	5.47	4.94	6.00	15.1	14.3	15.9
	1816	5.10	2.80	7.05	32.77	26.60	38.36	6.50	2.19	13.34	39.73	37.04	41.88	0.49	0.48	0.50	15.5	14.5	16.2
809-1A	1815	0.44	0.00	1.94	0.68	0.18	1.44	39.63	25.24	50.00	28.49	20.71	33.97	0.47	0.20	0.73	14.8	12.9	16.1
	1816	6.51	3.41	9.35	28.34	23.88	33.17	10.56	2.37	23.06	41.68	37.97	49.38	0.08	0.02	0.13	7.9	7.3	8.4
810-1A	1815	1.12	0.09	3.80	0.81	0.14	2.20	41.91	33.75	65.77	31.59	27.14	45.85	0.53	0.28	0.98	14.9	12.2	17.5
	1816	8.19	3.02	12.98	27.92	23.02	32.93	9.44	2.94	14.04	42.29	37.38	44.94	0.14	0.00	0.26	8.4	6.5	14.6
811-1A	1815	1.04	0.17	2.84	1.27	0.05	9.62	50.29	41.97	65.74	37.18	30.24	49.02	0.68	0.40	1.86	14.7	12.4	16.3
	1816	9.51	5.13	12.18	27.64	22.44	33.29	11.41	4.52	17.96	44.63	40.23	50.00	0.18	0.11	0.40	8.0	6.9	9.1
812-1A	1815	5.54	0.49	11.38	0.87	0.15	2.20	42.55	34.36	67.46	39.02	30.71	58.22	0.60	0.26	1.01	16.3	14.6	19.5
	1816	17.96	9.84	27.08	21.89	14.54	29.31	9.14	3.12	13.56	47.71	42.70	51.80	0.07	0.03	0.10	6.9	5.6	10.1
814-1A	1815	4.13	1.07	8.93	0.53	0.00	1.80	40.31	34.58	51.93	33.30	28.37	39.58	0.31	0.25	0.37	14.6	12.4	15.9
	1816	15.16	6.06	24.42	23.56	18.09	28.61	11.05	4.83	24.82	46.69	42.25	57.99	0.11	0.07	0.16	8.2	6.1	9.2
815-1A	1815	8.29	1.33	20.24	0.89	0.08	3.61	33.80	20.17	43.53	35.21	30.00	41.19	0.61	0.32	1.34	14.8	12.8	17.0
	1816	16.46	6.01	23.84	20.18	12.97	28.98	8.18	0.22	16.78	44.95	39.43	50.29	0.18	0.07	0.40	8.4	6.0	9.9
816-1A	1815	4.36	1.40	9.66	0.70	0.08	2.17	38.87	33.79	43.25	33.41	30.53	36.51	0.57	0.26	0.77	14.8	13.2	16.6
	1816	13.13	4.51	16.74	22.17	19.18	27.87	10.06	6.57	17.02	43.42	39.02	45.62	0.19	0.15	0.29	7.8	5.0	9.5
817-1A	1815	2.61	1.48	4.23	0.51	0.04	1.35	22.49	11.00	29.12	19.56	10.84	23.99	6.67	5.00	13.55	16.0	14.5	19.4
	1816	12.45	9.66	15.32	24.33	19.67	28.04	7.82	3.52	14.05	42.77	40.99	45.75	0.56	0.40	0.84	8.9	7.8	9.8
818-1A	1815	3.18	1.67	5.42	0.43	0.08	0.86	26.71	21.12	31.15	23.34	20.03	26.68	4.88	3.17	7.20	14.9	13.7	16.0
	1816	12.98	5.94	16.92	23.69	15.61	31.70	7.52	3.95	11.53	42.73	38.85	45.75	0.49	0.34	0.69	9.5	8.6	10.9

RUN SUMMARY - SOLIDS ANALYTICAL DATA (CONTINUED)

		PERCENT SULFITE OXIDATION			STOICHIOMETRIC RATIO			PERCENT IONIC IMBALANCE		
RUN NO.	ANALYTICAL POINT	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX
808-1A	1815	97.8	94.3	99.3	1.02	1.00	1.03	3.1	-0.9	8.4
	1816	13.7	5.1	27.7	1.20	1.09	1.30		-2.0	2.3
809-1A	1815	97.8	93.3	99.4	1.02	1.00	1.06	-1.5	-7.9	6.1
	1816	21.7	5.8	37.2	1.27	1.10	1.50	2.9	-2.8	8.4
810-1A	1815	97.6	92.5	99.6	1.05	1.00	1.18	0.1	-7.7	7.2
	1816	21.1	8.3	30.6	1.35	1.13	1.67	1.9	-7.7	8.2
811-1A	1815	97.2	78.9	99.9	1.04	1.01	1.09	-1.5	-8.2	4.5
	1816	24.4	13.9	37.4	1.39	1.17	1.66	0.8	-7.1	6.9
812-1A	1815	97.6	94.4	99.5	1.24	1.02	1.46	3.5	-6.4	8.4
	1816	24.9	9.3	37.3	1.96	1.37	2.70	-1.6	-8.4	5.5
814-1A	1815	98.4	95.1	100.0	1.19	1.05	1.41	-2.1	-8.0	6.6
	1816	26.0	12.8	46.0	1.74	1.19	2.39	-2.1	-8.2	8.4
815-1A	1815	96.7	87.8	99.7	1.49	1.06	2.66	0.4	-8.3	6.7
	1816	24.5	0.7	42.0	1.98	1.23	2.81	1.3	-7.6	6.4
816-1A	1815	97.8	92.8	99.8	1.21	1.06	1.51	-0.1	-7.3	5.9
	1816	26.4	17.9	37.7	1.65	1.17	1.89	0.4	-6.5	7.0
817-1A	1815	96.7	90.7	99.8	1.23	1.09	1.46	-0.1	-8.2	7.8
	1816	20.4	9.8	34.8	1.60	1.44	1.85	0.2	-8.5	7.8
818-1A	1815	98.1	96.5	99.7	1.22	1.11	1.40	0.7	-6.7	7.1
	1816	20.7	10.1	35.8	1.65	1.25	2.00	0.3	-6.9	7.0

RUN SUMMARY - SOLIDS ANALYTICAL DATA

CONCENTRATIONS IN SOLIDS, WT %

RUN NO.	ANALYTICAL POINT	CO2			SO2			SO3			CAO			ACID INSOLUBLES			SOLIDS IN SLURRY, WT %		
		AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX
819-1A	1815	3.41	0.86	8.71	0.48	0.00	3.32	26.34	13.15	36.37	23.39	16.45	28.87	4.55	1.92	8.67	15.0	11.8	17.4
	1816	13.12	7.53	20.54	23.59	16.28	30.10	7.70	1.95	15.18	43.36	39.81	46.31	0.49	0.15	1.01	10.0	7.1	13.0
819-1B	1815	2.90	1.92	4.48	0.41	0.17	1.21	25.16	18.43	29.73	22.26	17.69	25.07	4.99	2.89	8.01	15.2	13.5	16.7
	1816	12.78	9.49	15.79	23.87	20.26	28.68	6.89	4.71	11.41	42.55	40.96	44.32	0.50	0.37	0.73	9.6	8.5	10.5
820-1A	1815	1.19	0.10	3.96	0.38	0.08	2.08	25.26	19.51	30.35	19.88	13.65	26.86	5.60	3.22	9.77	14.7	11.4	18.8
	1816	11.59	2.42	19.02	20.49	14.88	31.85	10.76	3.82	19.15	39.29	35.11	44.77	0.51	0.04	0.65	5.8	2.2	8.5
820-1B	1815	1.87	1.10	2.72	1.62	0.08	4.56	23.68	17.96	28.41	20.14	15.43	24.13	5.75	4.36	7.89	14.6	11.3	18.7
	1816	11.36	6.67	16.16	24.82	18.83	29.66	6.47	2.33	10.30	40.56	38.90	42.11	0.60	0.50	0.70	8.3	7.5	9.6
820-1C	1815	4.46	3.02	6.12	15.13	12.12	19.03	10.45	7.85	13.40	25.23	22.38	28.86	5.70	4.53	6.98	15.2	13.9	17.6
	1816	11.92	8.78	14.46	24.80	22.80	27.58	7.73	3.69	10.52	41.57	39.84	42.53	0.73	0.64	0.80	10.5	9.4	11.7
821-1A	1815	2.47	2.47	2.47	0.09	0.09	0.09	14.99	14.99	14.99	13.36	13.36	13.36	9.28	9.28	9.28	16.3	16.3	16.3
	1816																		
822-1A	1815	3.28	0.20	10.40	1.18	0.20	12.00	21.00	6.90	29.33	19.28	10.40	27.30	6.42	4.80	8.49	14.4	12.0	17.9
	1816	13.92	7.00	24.60	22.61	12.50	28.90	7.65	3.38	17.70	41.59	39.60	45.90	0.58	0.50	0.70	7.9	6.5	10.3
822-1B	1815	1.11	0.10	4.00	0.45	0.20	1.10	22.19	18.45	26.28	16.67	12.70	19.90	6.23	4.30	8.90	13.3	10.3	15.2
	1816	12.46	9.20	15.70	22.09	18.10	26.40	8.12	3.40	13.90	40.30	37.90	42.90	0.43	0.30	0.70	5.6	4.6	7.6
823-1A	1815																		
	1816	15.29	7.70	19.20	1.51	0.40	3.20	11.69	6.65	16.80	29.06	23.70	33.90	4.38	3.00	5.80	13.3	10.6	15.6
824-1A	1815																		
	1816	10.74	7.60	15.90	7.46	2.90	10.70	8.67	4.33	12.10	25.83	22.80	28.50	5.49	4.70	6.80	14.1	12.9	16.5

RUN SUMMARY - SOLIDS ANALYTICAL DATA (CONTINUED)

RUN NO.	ANALYTICAL POINT	PERCENT SULFITE OXIDATION			STOICHIOMETRIC RATIO			PERCENT IONIC IMBALANCE		
		AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX
819-1A	1815	97.7	85.9	100.0	1.24	1.05	2.10	0.7	-8.1	7.8
	1816	20.7	6.2	40.6	1.66	1.31	2.17	1.3	-7.2	7.2
819-1B	1815	98.0	93.5	99.2	1.21	1.12	1.43	2.5	-6.9	8.1
	1816	18.8	13.9	31.1	1.64	1.41	1.80	1.3	-5.7	7.2
820-1A	1815	98.1	88.2	99.6	1.08	1.01	1.26	1.1	-7.1	8.2
	1816	29.7	11.9	50.7	1.63	1.09	2.24	-2.5	-8.3	5.8
820-1B	1815	92.3	79.1	99.5	1.13	1.07	1.19	-1.4	-8.1	8.3
	1816	17.3	6.4	26.0	1.57	1.30	1.95	-0.4	-8.1	7.2
820-1C	1815	35.8	27.8	46.9	1.28	1.19	1.39	-4.0	-8.0	3.1
	1816	19.8	10.2	26.1	1.56	1.40	1.75	-1.8	-8.5	7.0
821-1A	1815	99.3	99.3	99.3	1.30	1.30	1.30	-2.7	-2.7	-2.7
	1816									
822-1A	1815	93.1	31.5	99.0	1.27	1.01	1.86	-3.5	-8.0	4.5
	1816	21.0	11.6	38.7	1.83	1.29	3.10	-3.1	-7.8	6.5
822-1B	1815	97.6	93.8	98.8	1.09	1.01	1.33	-4.3	-8.3	3.4
	1816	22.5	10.8	34.8	1.65	1.45	1.91	-1.6	-7.4	4.9
823-1A	1815									
	1816	86.1	73.3	95.1	3.17	1.79	4.39	0.3	-5.9	7.2
824-1A	1815									
	1816	48.6	24.4	75.7	2.12	1.71	2.94	-1.8	-7.7	5.1

RUN SUMMARY - SOLIDS ANALYTICAL DATA

CONCENTRATIONS IN SOLIDS, WT %

RUN NO.	ANALYTICAL POINT	CO2			SO2			SO3			CAO			ACID INSOLUBLES			SOLIDS IN SLURRY, WT %		
		AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX
825-1A	1815																		
	1816	6.71	3.30	10.90	13.44	8.00	17.70	10.79	7.48	16.70	27.43	24.60	31.90	5.05	4.30	5.80	14.7	13.3	16.1
826-1A	1815																		
	1816	8.06	3.90	13.20	15.25	10.00	22.60	7.67	3.75	12.90	28.65	22.40	32.10	5.07	3.80	6.20	15.2	12.8	17.7
851-1A	1815	0.24	0.11	0.51	0.54	0.36	0.73	22.18	17.46	28.52	17.30	13.74	22.13	6.07	5.70	6.44	15.2	13.9	16.5
	1816	3.65	3.14	4.41	35.12	30.89	39.05	7.26	3.37	14.68	43.29	41.28	45.41	0.35	0.11	0.73	5.9	5.6	6.3
852-1A	1815	0.57	0.11	1.78	3.34	0.01	15.91	19.65	10.12	32.98	18.42	9.16	25.99	5.89	5.85	5.92	15.6	11.5	17.7
	1816	3.28	2.86	4.23	35.67	33.66	36.91	6.73	2.71	12.99	42.66	37.95	44.63	0.39	0.37	0.42	9.1	6.4	10.6
853-1A	1815	0.46	0.15	1.87	0.66	0.01	1.38	21.47	10.12	32.80	17.05	8.88	24.76	8.59	6.12	11.63	15.4	12.9	17.0
	1816	3.76	2.93	4.95	35.39	26.06	37.30	8.95	3.53	28.09	44.24	41.26	51.65	0.37	0.19	0.93	6.2	5.2	7.2
854-1A	1815	0.31	0.05	1.15	0.64	0.07	2.53	21.27	8.38	32.98	16.01	6.13	24.27	7.05	5.32	8.76	15.1	12.4	16.9
	1816	4.11	3.47	4.79	35.80	31.39	39.09	6.19	2.28	12.22	42.85	40.96	44.43	0.14	0.12	0.19	6.1	5.3	7.8
855-1A	1815	0.30	0.04	0.65	0.57	0.15	1.08	48.64	45.53	57.61	34.73	31.62	42.74	0.93	0.32	1.53	14.7	12.3	16.8
	1816	3.95	1.82	5.28	35.07	31.03	36.71	9.41	3.23	13.60	42.06	40.29	43.66	0.05	0.00	0.09	7.2	6.7	8.4
856-1A	1815	0.29	0.00	1.02	0.72	0.24	2.21	35.58	25.96	50.74	26.05	20.83	39.49	1.58	0.11	8.08	15.3	12.5	16.7
	1816	4.39	3.77	5.80	35.82	32.91	37.24	6.28	3.08	12.42	42.46	38.52	44.71	0.24	0.02	0.77	7.8	7.1	8.2
857-1A	1815	0.07	0.00	0.27	0.91	0.19	3.25	37.65	24.66	53.50	27.58	18.81	38.73	0.68	0.18	1.32	14.8	10.0	18.2
	1816	3.64	2.81	4.12	35.50	33.19	38.04	5.28	1.92	10.41	41.95	40.69	43.78	0.05	0.03	0.08	7.7	7.2	8.6
858-1A	1815	0.45	0.00	1.45	0.63	0.00	2.15	36.33	28.07	54.10	26.24	19.87	39.39	0.21	0.08	0.39	7.7	6.5	8.8
	1816	3.52	3.02	4.21	36.56	31.53	39.09	7.49	2.11	24.26	43.50	41.59	48.86	0.09	0.02	0.18	15.3	13.3	16.7

RUN SUMMARY - SOLIDS ANALYTICAL DATA (CONTINUED)

RUN NO.	ANALYTICAL POINT	PERCENT SULFITE OXIDATION AVG	PERCENT SULFITE OXIDATION MIN	PERCENT SULFITE OXIDATION MAX	STOICHIOMETRIC RATIO AVG	STOICHIOMETRIC RATIO MIN	STOICHIOMETRIC RATIO MAX	PERCENT IONIC IMBALANCE AVG	PERCENT IONIC IMBALANCE MIN	PERCENT IONIC IMBALANCE MAX
825-1A	1815									
	1816	39.4	25.3	62.6	1.45	1.22	1.79	-1.5	-8.0	8.1
826-1A	1815									
	1816	28.8	11.7	48.9	1.58	1.25	2.23	-1.3	-8.5	6.5
851-1A	1815	97.0	95.2	97.9	1.02	1.01	1.03	5.8	3.9	8.4
	1816	14.1	6.9	27.6	1.13	1.10	1.17	6.5	3.3	7.7
852-1A	1815	84.8	36.1	99.9	1.04	1.02	1.10	5.4	1.6	7.4
	1816	12.9	5.9	23.6	1.12	1.10	1.16	6.0	3.6	8.2
853-1A	1815	96.2	92.6	99.9	1.05	1.01	1.19	5.1	1.1	7.5
	1816	16.3	7.0	38.8	1.13	1.10	1.19	5.1	-8.3	8.5
854-1A	1815	96.2	86.0	99.4	1.03	1.00	1.09	0.6	-7.2	6.1
	1816	12.0	4.8	23.7	1.15	1.13	1.18	4.5	-0.2	7.8
855-1A	1815	98.5	97.2	99.6	1.01	1.00	1.02	-0.8	-5.2	6.0
	1816	17.6	6.8	26.0	1.14	1.06	1.18	-0.7	-7.9	7.5
856-1A	1815	97.5	94.8	99.1	1.01	1.00	1.05	0.6	-5.2	7.7
	1816	12.2	6.3	22.5	1.16	1.13	1.20	2.5	-6.2	7.9
857-1A	1815	96.9	87.6	99.3	1.00	1.00	1.02	1.2	-6.5	7.6
	1816	10.6	4.0	20.1	1.13	1.10	1.16	6.0	2.1	8.4
858-1A	1815	97.8	91.5	100.0	1.02	1.00	1.07	-1.5	-7.7	2.5
	1816	13.5	4.1	35.7	1.12	1.09	1.14	4.1	-6.1	7.5

RUN SUMMARY - SOLIDS ANALYTICAL DATA

CONCENTRATIONS IN SOLIDS, WT %

RUN NO.	ANALYTICAL POINT	CO2 AVG	CO2 MIN	CO2 MAX	SO2 AVG	SO2 MIN	SO2 MAX	SO3 AVG	SO3 MIN	SO3 MAX	CAO AVG	CAO MIN	CAO MAX	ACID INSOLUBLES AVG	ACID INSOLUBLES MIN	ACID INSOLUBLES MAX	SOLIDS IN SLURRY, WT % AVG	SOLIDS IN SLURRY, WT % MIN	SOLIDS IN SLURRY, WT % MAX
859-1A	1815	0.95	0.35	1.87	8.15	3.86	11.40	36.07	25.41	54.94	34.34	26.10	40.87	0.11	0.05	0.19	14.1	12.6	15.6
	1816	4.43	3.13	4.95	37.67	34.74	39.55	4.88	1.04	15.65	43.75	41.67	47.07	0.11	0.02	0.20	7.2	6.8	7.6
859-1B	1815	0.17	0.00	0.46	0.51	0.00	1.64	43.75	29.95	57.72	32.28	21.94	40.40	0.39	0.28	0.49	14.6	13.7	16.1
	1816	4.24	3.47	5.11	34.75	34.02	35.83	6.32	2.57	9.45	42.86	42.14	43.68	0.08	0.02	0.14	7.6	7.3	7.8
859-1C	1815	1.04	0.36	1.60	10.95	4.34	15.20	29.63	23.13	42.69	31.33	21.63	40.61	0.34	0.07	0.55	15.2	12.9	16.8
	1816	4.33	3.57	5.34	34.83	32.21	36.94	11.13	7.05	14.32	43.77	42.48	44.99	0.22	0.03	0.30	7.3	6.9	7.7
859-1D	1815	2.95	2.25	4.15	28.24	23.16	31.74	16.68	10.76	24.70	41.42	38.25	43.18	0.32	0.29	0.35	14.2	13.8	14.6
	1816	4.89	3.96	5.55	37.87	36.19	39.45	5.34	1.43	9.91	44.69	40.54	47.39	0.03	0.02	0.03	7.1	6.6	7.5
860-1A	1815	0.20	0.00	0.88	0.65	0.00	1.80	47.07	27.50	69.82	33.88	20.36	49.23	0.40	0.25	0.56	15.5	12.4	26.7
	1816	5.05	4.67	5.44	36.54	34.56	38.47	5.15	2.17	10.97	44.16	40.68	45.21	0.05	0.02	0.08	7.0	6.3	7.7
861-1A	1815	0.21	0.00	0.44	0.65	0.06	2.17	44.14	43.16	45.27	31.93	31.01	33.29	0.22	0.02	0.32	14.3	13.3	16.5
	1816	4.41	3.14	5.80	33.92	29.68	36.39	9.36	5.50	17.04	42.39	41.17	44.02	0.06	0.01	0.16	7.3	7.0	7.9
862-1A	1815	0.29	0.00	0.91	0.50	0.19	1.66	23.37	8.02	28.98	17.04	6.61	20.00	6.35	5.21	10.22	14.9	13.8	15.9
	1816	2.97	2.37	3.65	33.97	31.85	36.54	9.33	6.84	11.80	39.95	38.82	41.34	0.93	0.49	1.52	17.2	12.7	19.7
863-1A	1815	0.26	0.05	2.02	0.74	0.03	6.42	26.49	16.60	34.00	19.78	12.10	25.07	5.23	2.25	8.21	15.3	13.3	17.7
	1816	2.95	1.19	6.49	31.34	25.69	37.60	10.41	2.51	17.83	38.58	34.00	42.11	0.55	0.02	0.84	10.4	8.7	12.1
864-1A	1815	0.19	0.05	0.38	0.31	0.09	0.71	21.40	13.61	27.89	15.48	10.77	19.92	7.33	5.12	9.38	15.9	13.8	17.6
	1816	3.27	2.69	3.86	27.56	25.31	32.42	11.17	8.01	14.01	36.49	34.49	38.56	0.93	0.49	1.20	9.5	9.0	10.1
865-1A	1815	0.30	0.11	0.60	2.50	0.36	9.41	22.56	16.37	28.36	18.69	13.64	21.96	5.92	4.23	8.51	15.4	13.7	17.2
	1816	2.59	1.86	3.59	28.04	23.88	31.85	12.45	9.02	16.34	36.47	35.37	38.03	0.88	0.58	1.64	10.1	8.6	12.2

RUN SUMMARY - SOLIDS ANALYTICAL DATA (CONTINUED)

RUN NO.	ANALYTICAL POINT	PERCENT SULFITE OXIDATION			STOICHIOMETRIC RATIO			PERCENT IONIC IMBALANCE		
		AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX
859-1A	1815	77.2	68.0	91.9	1.04	1.01	1.08	2.1	-5.8	7.8
	1816	9.0	2.1	25.8	1.16	1.11	1.18	3.9	-3.2	7.5
859-1B	1815	98.6	96.6	100.0	1.01	1.00	1.02	3.2	-3.9	7.0
	1816	12.6	5.4	17.7	1.16	1.12	1.19	6.1	3.1	8.5
859-1C	1815	68.5	57.4	81.1	1.04	1.02	1.07	-0.7	-7.0	4.8
	1816	20.3	13.5	25.4	1.15	1.13	1.17	-0.1	-7.2	7.2
859-1D	1815	31.9	22.5	46.0	1.10	1.08	1.14	3.0	-4.3	7.0
	1816	10.0	2.8	17.4	1.17	1.14	1.19	3.5	0.0	6.1
860-1A	1815	98.3	95.8	100.0	1.01	1.00	1.02	0.2	-7.2	6.4
	1816	10.0	4.4	20.2	1.18	1.16	1.20	4.9	0.9	7.5
861-1A	1815	98.2	94.1	99.8	1.01	1.00	1.02	0.5	-5.0	3.9
	1816	18.0	11.4	31.5	1.16	1.11	1.20	1.2	-3.3	6.8
862-1A	1815	97.2	90.9	99.1	1.02	1.00	1.07	-0.8	-7.5	7.7
	1816	18.0	13.8	22.9	1.11	1.09	1.13	-0.3	-5.6	7.6
863-1A	1815	96.7	72.7	99.8	1.02	1.00	1.16	1.2	-8.4	8.1
	1816	20.9	5.1	35.7	1.11	1.04	1.25	0.2	-8.3	7.4
864-1A	1815	98.1	94.8	99.6	1.02	1.00	1.03	-0.1	-5.7	5.6
	1816	24.5	18.4	30.1	1.13	1.10	1.16	1.0	-5.2	7.4
865-1A	1815	87.8	59.9	98.4	1.02	1.01	1.04	1.7	-6.1	6.6
	1816	26.3	18.5	35.0	1.10	1.07	1.14	-0.3	-4.0	4.4

RUN SUMMARY - SOLIDS ANALYTICAL DATA

CONCENTRATIONS IN SOLIDS, WT %

RUN NO.	ANALYTICAL POINT	CO2 AVG	CO2 MIN	CO2 MAX	SO2 AVG	SO2 MIN	SO2 MAX	SO3 AVG	SO3 MIN	SO3 MAX	CAO AVG	CAO MIN	CAO MAX	ACID INSOLUBLES AVG	ACID INSOLUBLES MIN	ACID INSOLUBLES MAX	SOLIDS IN SLURRY, WT % AVG	SOLIDS IN SLURRY, WT % MIN	SOLIDS IN SLURRY, WT % MAX
866-1A	1815	0.34	0.11	0.88	2.36	0.08	10.04	24.87	20.71	33.97	19.95	15.[illegible]0	24.62	4.93	2.51	7.03	15.5	14.2	16.9
	1816	3.39	1.32	6.44	27.35	23.52	31.49	11.50	7.85	15.83	36.45	33.36	38.28	0.77	0.53	1.10	9.9	8.7	11.1
867-1A	1815	0.19	0.08	0.43	0.38	0.08	1.07	28.78	23.46	31.85	21.43	16.09	23.95	4.31	3.03	5.74	14.5	12.9	15.6
	1816	3.05	2.31	4.12	30.85	28.10	33.66	9.53	6.66	12.25	37.29	35.81	39.59	0.75	0.50	0.95	11.7	7.9	14.6

RUN SUMMARY - SOLIDS ANALYTICAL DATA (CONTINUED)

RUN NO.	ANALYTICAL POINT	PERCENT SULFITE OXIDATION			STOICHIOMETRIC RATIO			PERCENT IONIC IMBALANCE		
		AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX
866-1A	1815	90.4	62.9	99.5	1.02	1.01	1.05	0.2	-7.6	6.3
	1816	25.2	16.7	32.1	1.14	1.05	1.28	0.3	-7.3	5.8
867-1A	1815	98.4	96.0	99.7	1.01	1.01	1.03	3.0	-4.4	7.6
	1816	19.8	14.1	25.9	1.12	1.09	1.17	-0.8	-6.7	3.5

TCA RUN DEFINITION

RUN NO.	START DATE	START TIME	END DATE	END TIME	HOURS ON STRM	FACT OR TIME
TFG-2A	02/28/77	1330	03/03/77	1807	76	T
TFG-2B	02/04/77	0530	02/10/77	0530	128	T
TFG-2C	02/10/77	1310	02/14/77	1025	93	T
TFG-2D	02/15/77	1730	02/19/77	1505	93	T
TFG-2E	02/19/77	1505	02/23/77	1515	96	T
TFG-2F	02/23/77	1515	02/28/77	0750	112	T
590-2A	01/24/78	1347	01/26/78	1010	45	T
590-2B	02/02/78	1255	02/06/78	0900	92	T
591-2A	03/27/78	1345	04/05/78	1220	207	T
592-2A	04/05/78	1220	04/21/78	0730	293	T
593-2A	04/21/78	1135	05/02/78	0825	260	T
594-2A	05/02/78	1710	05/06/78	1955	99	T
618-2A	02/06/78	0900	02/13/78	1240	162	T
618-2B	02/13/78	1240	02/17/78	0735	88	T
619-2A	02/17/78	1400	03/02/78	0815	306	T
620-2A	03/02/78	1200	03/06/78	2145	106	T
621-2A	03/17/78	0935	03/27/78	0810	239	T
622-2A	05/08/78	1830	05/12/78	1400	91	T
622-2B	05/12/78	1400	05/19/78	1600	125	T
623-2A	05/19/78	1600	05/31/78	0520	271	T
624-2A	06/08/78	1235	06/19/78	1735	269	T
705-2A	01/04/77	1210	01/14/77	0812	236	T
706-2A	01/14/77	1350	01/04/77	0530	339	T
707-2A	03/04/77	1350	03/09/77	0730	113	T
708-2A	03/09/77	1450	03/14/77	2400	128	T
709-2A	03/15/77	0000	03/17/77	0737	56	T
710-2A	03/17/77	1405	03/24/77	0744	162	T
711-2A	03/24/77	1349	03/28/77	1135	93	T
712-2A	03/28/77	1550	04/02/77	1300	117	T
713-2A	06/15/77	1305	06/24/77	1145	202	T
714-2A	08/30/77	1200	09/07/77	2020	201	T
714-2B	09/07/77	2000	09/09/77	0800	36	T
715-2A	10/07/77	1439	10/14/77	0735	161	T
716-2A	10/14/77	1300	10/20/77	0325	135	T
717-2A	10/20/77	1408	11/21/77	0820	747	T
718-2A	11/24/77	1200	11/30/77	0625	143	T
719-2A	12/01/77	1705	12/09/77	0755	183	T
801-2A	06/24/77	1145	06/28/77	1715	102	T
801-2B	06/28/77	1715	06/30/77	1600	47	T
802-2A	07/01/77	1308	07/07/77	1135	142	T
803-2A	07/08/77	1401	07/15/77	1042	165	T
804-2A	07/15/77	1042	07/22/77	0820	166	T
805-2A	07/22/77	1250	07/28/77	0820	140	T
806-2A	07/28/77	1305	08/02/77	0800	115	T

TCA RUN DEFINITION

RUN NO.	START DATE	START TIME	END DATE	END TIME	HOURS ON STRM	FACT OR TIME
807-2A	08/02/77	1505	08/10/77	0810	185	T
808-2A	08/10/77	1140	08/17/77	0510	162	T
809-2A	08/17/77	1525	08/23/77	2050	149	T
810-2A	08/24/77	1410	08/29/77	2355	130	T
811-2A	09/09/77	1157	09/16/77	0738	164	T
812-2A	09/16/77	1010	09/22/77	0735	141	T
813-2A	09/23/77	2205	09/29/77	0735	130	T
814-2A	09/29/77	1000	10/04/77	0910	119	T
815-2A	12/09/77	0950	12/14/77	1115	75	T
816-2A	12/14/77	1315	12/16/77	1430	48	T
817-2A	12/16/77	1430	12/23/77	0740	161	T
818-2A	12/23/77	0740	12/30/77	1210	131	T
818-2B	12/30/77	1210	01/05/78	0740	140	T
819-2A	01/06/78	1401	01/13/78	1200	164	T
820-2A	01/13/78	1200	01/24/78	0805	259	T
821-2A	05/31/78	1655	06/08/78	0735	182	T

TCA SYSTEM CONFIGURATION

RUN NO.	TCA NO. BEDS	TCA TOT BED HGT	TCA SPHERE TYPE	NO.OF HOLD TANKS	M.E. SYSTEM CONFIG	M.E. WASH B/T	DE-WATER SYSTEM	OXID CONFIG FLAG	ALK ADDN PT.	RUN NO.
TFG-2A	3	15.0	FOAM	1	1-3P/OV	I/I	CL		EHT	TFG-2A
TFG-2B	3	15.0	FOAM	3	1-3P/OV	I/I	CL		EHT	TFG-2B
TFG-2C	3	15.0	FOAM	3	1-3P/OV	C/I	CL		EHT	TFG-2C
TFG-2D	3	15.0	FOAM	3	1-3P/OV	C/I	CL		EHT	TFG-2D
TFG-2E	3	15.0	FOAM	3	1-3P/OV	C/I	CL		EHT	TFG-2E
TFG-2F	3	15.0	FOAM	3	1-3P/OV	C/I	CL		EHT	TFG-2F
590-2A	3	15.0	FOAM	1	1-3P/OV	I/I	CL/CE		DNC	590-2A
590-2B	3	15.0	FOAM	1	1-3P/OV	I/I	CL/CE		DNC	590-2B
591-2A	3	15.0	FOAM	1	1-3P/OV	I/S	CL/CE		EHT	591-2A
592-2A	3	15.0	FOAM	1	1-3P/OV	I/S	CL/CE		EHT	592-2A
593-2A	3	15.0	FOAM	1	1-3P/OV	I/S	CL/CE		EHT	593-2A
594-2A	3	15.0	FOAM	1	1-3P/OV	I/S	CL/CE		EHT	594-2A
618-2A	3	15.0	FOAM	1	1-3P/OV	I/I	CL/CE		DNC	618-2A
618-2B	3	15.0	FOAM	1	1-3P/OV	I/I	CL/CE		DNC	618-2B
619-2A	3	15.0	FOAM	1	1-3P/OV	I/S	CL/CE		DNC	619-2A
620-2A	3	15.0	FOAM	1	1-3P/OV	I/S	CL/CE		DNC	620-2A
621-2A	3	15.0	FOAM	1	1-3P/OV	I/S	CL/CE		DNC	621-2A
622-2A	3	15.0	FOAM	1	1-3P/OV	I/S	CL/CE		EHT	622-2A
622-2B	3	15.0	FOAM	1	1-3P/OV	I/S	CL/CE		DNC	622-2B
623-2A	3	15.0	FOAM	1	1-3P/OV	I/S	CL/CE		DNC	623-2A
624-2A	3	15.0	FOAM	1	1-3P/OV	I/S	CL		DNC	624-2A
705-2A	3	15.0	FOAM	3			CL		EHT	705-2A
706-2A	3	15.0	FOAM	3			CL		EHT	706-2A
707-2A	3	15.0	FOAM	1	1-3P/OV	I/I	CL		EHT	707-2A
708-2A	3	15.0	FOAM	1	1-3P/OV	I/I	CL		EHT	708-2A
709-2A	3	15.0	FOAM	1	1-3P/OV	I/I	CL		EHT	709-2A
710-2A	3	15.0	FOAM	1	1-3P/OV	I/I	CL		EHT	710-2A
711-2A	3	15.0	FOAM	1	1-3P/OV	I/I	CL		EHT	711-2A
712-2A	3	15.0	FOAM	3	1-3P/OV	I/I	CL		EHT	712-2A
713-2A	3	15.0	FOAM	1	1-3P/OV	C/I	CL		EHT	713-2A
714-2A	3	15.0	FOAM	1	1-3P/OV	C/I	CL		EHT	714-2A
714-2B	3	15.0	FOAM	1	1-3P/OV	C/S	LAM		EHT	714-2B
715-2A	3	21.0	FOAM	3	1-3P/OV	C/I	CL		EHT	715-2A
716-2A	3	30.0	FOAM	3	1-3P/OV	C/I	CL		EHT	716-2A
717-2A	3	22.5	FOAM	3	1-3P/OV	C/I	CL		EHT	717-2A
718-2A				1	1-3P/OV	C/I	CL		EHT	718-2A
719-2A				1	1-3P/OV	I/I	CL		EHT	719-2A
801-2A	3	15.0	FOAM	1	1-3P/OV	C/I	CL	2	EHT	801-2A
801-2B	3	15.0	FOAM	1	1-3P/OV	C/I	CL		EHT	801-2B
802-2A	3	15.0	FOAM	1	1-3P/OV	C/I	CL		EHT	802-2A
803-2A	3	15.0	FOAM	1	1-3P/OV	C/I	CL		EHT	803-2A
804-2A	3	15.0	FOAM	1	1-3P/OV	C/I	CL		EHT	804-2A
805-2A	3	15.0	FOAM	1	1-3P/OV	C/I	CL		EHT	805-2A
806-2A	3	15.0	FOAM	1	1-3P/OV	C/I	CL		EHT	806-2A

TCA SYSTEM CONFIGURATION

RUN NO.	TCA NO. BEDS	TCA TOT BED HGT	TCA SPHERE TYPE	NO.OF HOLD TANKS	M.E. SYSTEM CONFIG	M.E. WASH B/T	DE-WATER SYSTEM	OXID CONFIG FLAG	ALK ADDN PT.	RUN NO.
807-2A	3	15.0	FOAM	1	1-3P/OV	C/I	CL	3	EHT	807-2A
808-2A	3	15.0	FOAM	2	1-3P/OV	C/I	CL		EHT	808-2A
809-2A	3	15.0	FOAM	2	1-3P/OV	C/I	CL/F		EHT	809-2A
810-2A	3	15.0	FOAM	2	1-3P/OV	C/I	CL/F		EHT	810-2A
811-2A	3	15.0	FOAM	2	1-3P/OV	C/I	CL		EHT	811-2A
812-2A	3	15.0	FOAM	2	1-3P/OV	C/I	CL		EHT	812-2A
813-2A	3	15.0	FOAM	1	1-3P/OV	C/I	CL		EHT	813-2A
814-2A	3	15.0	FOAM	1	1-3P/OV	C/I	CL		EHT	814-2A
815-2A	3	15.0	FOAM	1	1-3P/OV	C/I	CL		EHT	815-2A
816-2A	3	22.0	FOAM	1	1-3P/OV	C/I	CL		EHT	816-2A
817-2A	3	22.0	FOAM	1	1-3P/OV	C/I	CL		EHT	817-2A
818-2A	3	22.0	FOAM	1	1-3P/OV	C/I	CL		EHT	818-2A
818-2B	3	22.0	FOAM	1	1-3P/OV	C/I	CL		EHT	818-2B
819-2A	3	22.0	FOAM	1	1-3P/OV	C/I	CL			819-2A
820-2A	3	22.0	FOAM	1	1-3P/OV	C/I	CL			820-2A
821-2A	3	15.0	FOAM	1	1-3P/OV	I/S	CL/CE	4	EHT	821-2A

TCA OPERATING CONDITIONS

RUN NO.	ALK TYPE	FLY ASH	MGO	PH CONTR POINT	GAS RATE ACFM	GAS VEL FPS	TCA LIQ RATE GPM	TCA L/G GAL/ MACF	SOLID RECIRC NOM %	SOLIDS DISCH RANGE %	TCA D.P. IN. H2O	M.E.SYSTEM D.P.RANGE IN.H2O	RUN NO.
TFG-2A	LS	Y	Y		30000	12.5	1200	49.8	15.0	50-55	6.6	0.44-0.50	TFG-2A
TFG-2B	LS	Y	N		30000	12.5	1200	49.8	15.0	30-39	9.2	0.56-0.60	TFG-2B
TFG-2C	LS	Y	N		30000	12.5	1200	49.8	15.0	32-42	8.6	0.49-0.60	TFG-2C
TFG-2D	LS	Y	N		20000	8.4	12	0.7	15.0	35-42	4.8	0.17-0.24	TFG-2D
TFG-2E	LS	Y	N		30000	12.5	600	24.9	15.0	37-43	4.9	0.49-0.56	TFG-2E
TFG-2F	LS	Y	N		30000	12.5	1200	49.8	15.0	34-42	6.8	0.43-0.49	TFG-2F
590-2A	LS	Y	N		30000	12.5	1200	49.8	13.8	62-70	11.4	0.40-0.48	590-2A
590-2B	LS	Y	N		30000	12.5	1200	49.8	14.7	56-60	10.5	0.42-0.52	590-2B
591-2A	LS	Y	Y		30000	12.5	1200	49.8	14.4	54-60	10.6	0.45-0.60	591-2A
592-2A	LS	Y	Y		30000	12.5	1200	49.8	15.0	51-59	8.9	0.52-0.60	592-2A
593-2A	LS	Y	Y		30000	12.5	900	37.4	14.8	52-62	7.2	0.49-0.66	593-2A
594-2A	LS	Y	Y		30000	12.5	1200	49.8	15.1	53-54	8.0	0.51-0.56	594-2A
618-2A	L	Y	N	7.00	30000	12.5	1200	49.8	7.8	60-65	11.0	0.40-0.52	618-2A
618-2B	L	Y	N	7.00	30000	12.5	1200	49.8	7.5	55-63	13.3	0.46-0.58	618-2B
619-2A	L	Y	Y	7.00	30000	12.5	1200	49.8	8.0	49-62	9.4	0.28-0.56	619-2A
620-2A	L	Y	Y	7.00	30000	12.5	900	37.4	8.1	52-60	8.2	0.46-0.62	620-2A
621-2A	L	Y	Y	7.00	30000	12.5	1200	49.8	8.1	48-62	10.8	0.50-0.64	621-2A
622-2A	L	Y	Y	7.00	30000	12.5	900	37.4	8.6	37-58	6.6	0.50-0.59	622-2A
622-2B	L	Y	Y	7.00	30000	12.5	900	37.4	8.0	37-61	6.7	0.51-0.60	622-2B
623-2A	L	Y	Y	7.00	30000	12.5	1200	49.8	8.2	53-65	7.0	0.54-0.68	623-2A
624-2A	L	Y	Y	7.00	30000	12.5	900	37.4	8.0	35-49	6.5	0.63-0.78	624-2A
705-2A	LS	N	N		30000	12.5	1200	49.8	15.0		8.0	0.43-0.52	705-2A
706-2A	LS	N	N		30000	12.5	1200	49.8	15.0			0.44-0.59	706-2A
707-2A	SL	N	N		30000	12.5	1200	49.8	15.0	38-42	6.6	0.45-0.57	707-2A
708-2A	LS	N	N		30000	12.5	1200	49.8	15.0	37-43	7.0	0.44-0.49	708-2A
709-2A	LS	N	N		30000	12.5	1200	49.8	15.0	37-41	6.4	0.44-0.49	709-2A
710-2A	LS	N	N		30000	12.5	1200	49.8	15.0	38-48	6.4	0.47-0.55	710-2A
711-2A	LS	N	N		30000	12.5	1200	49.8	15.0	35-40	6.6	0.50-0.62	711-2A
712-2A	LS	N	N		30000	12.5	1200	49.8	15.0	36-43	6.7	0.48-0.61	712-2A
713-2A	LS	Y	N		30000	12.5	1200	49.8	14.9	38-42	8.2	0.44-0.50	713-2A
714-2A	LS	Y	N		30000	12.5	1200	49.8	15.2	32-40	8.4	0.33-0.46	714-2A
714-2B	LS	Y	N				1200						714-2B
715-2A	LS	Y	N	5.80	30000	12.5	1000	41.5	15.0	30-42	11.2	0.44-0.55	715-2A
716-2A	LS	Y	N	5.75	27000	11.3	1000	46.1	14.4	33-41	14.4	0.34-0.44	716-2A
717-2A	LS	Y	N				1000		14.7	31-45	9.6	0.17-0.52	717-2A
718-2A	LS	Y	N		30000	12.5	1200	49.8	14.4	36-40	7.4	0.40-0.50	718-2A
719-2A	LS	Y	N		18000	7.5	1200	83.1	14.8	35-41	3.3	0.13-0.20	719-2A
801-2A	LS	Y	N		30000	12.5	1200	49.8	14.6	34-45	7.1	0.47-0.51	801-2A
801-2B	LS	Y	N		30000	12.5	1200	49.8	14.6	34-45	7.1	0.47-0.51	801-2B
802-2A	LS	Y	N		30000	12.5	1200	49.8	15.3	32-38	8.4	0.47-0.56	802-2A
803-2A	LS	Y	N	5.00	30000	12.5	1200	49.8	14.9	33-48	8.4	0.40-0.52	803-2A
804-2A	LS	Y	N	5.00	30000	12.5	1200	49.8	15.0	30-50	8.3	0.40-0.46	804-2A
805-2A	LS	Y	N	5.30	30000	12.5	1200	49.8	15.0	26-39	8.2	0.37-0.46	805-2A
806-2A	LS	Y	N	5.30	30000	12.5	1200	49.8	14.4	32-44	8.2	0.31-0.40	806-2A

TCA OPERATING CONDITIONS

RUN NO.	ALK TYPE	FLY ASH	MGO	PH CONTR POINT	GAS RATE ACFM	GAS VEL FPS	TCA LIQ RATE GPM	TCA L/G GAL/MACF	SOLID RECIRC NOM %	SOLIDS DISCH RANGE %	TCA D.P. IN. H2O	M.E.SYSTEM D.P.RANGE IN.H2O	RUN NO.
807-2A	LS	Y	N	5.40	30000	12.5	1200	49.8	14.9	28-44	8.5	0.34-0.44	807-2A
808-2A	LS	Y	N		30000	12.5	1200	49.8	14.8	24-64	8.2	0.44-0.50	808-2A
809-2A	LS	Y	N		30000	12.5	1200	49.8	14.1	80-89	8.4	0.35-0.43	809-2A
810-2A	LS	Y	N	5.40	30000	12.5	1200	49.8	15.0	84-91	8.6	0.35-0.45	810-2A
811-2A	LS	Y	N		30000	12.5	1200	49.8	14.6	35-50	8.1	0.30-0.47	811-2A
812-2A	LS	Y	N		30000	12.5	1200	49.8	15.0	32-44	8.0	0.30-0.50	812-2A
813-2A	LS	Y	N	5.30	30000	12.5	1200	49.8	15.0	35-44	9.6	0.47-0.58	813-2A
814-2A	LS	Y	N	5.30	30000	12.5	1200	49.8	14.6	33-42	9.6	0.47-0.55	814-2A
815-2A	LS	Y	N		30000	12.5	1000	41.5	14.9	35-41	11.9	0.44-0.54	815-2A
816-2A	LS	Y	N		30000	12.5	1000	41.5	15.2	38-42	13.0	0.40-0.48	816-2A
817-2A	LS	Y	N		20000	8.4	1000	62.3	14.4	31-48	6.8	0.15-0.26	817-2A
818-2A	LS	Y	N		25000	10.4	1000	49.8	14.8	38-42	8.5	0.26-0.36	818-2A
818-2B	LS	Y	N		25000	10.4	1000	49.8	14.3	35-42	8.2	0.24-0.35	818-2B
819-2A	LS	Y	N		20000	8.4	1000	62.3	12.9	32-42	7.4	0.11-0.26	819-2A
820-2A	LS	Y	N	5.90	20000	8.4	1000	62.3	13.8	32-42	6.9	0.11-0.21	820-2A
821-2A	LS	Y	Y		30000	12.5	1200	49.8	14.9	78-80	7.8	0.54-0.62	821-2A

TCA OPERATING CONDITIONS (CONTINUED)

RUN NO.	EFFLU RES TIME MIN	TCA LOW PH TANK RES TIME MIN.	OXID AIR RATE SCFM	EDUCTOR CIRCUL RATE GPM	BLEED OXID TANK PH	RUN NO.
TFG-2A	12.0					TFG-2A
TFG-2B	12.0					TFG-2B
TFG-2C	12.0					TFG-2C
TFG-2D	12.0					TFG-2D
TFG-2E	24.0					TFG-2E
TFG-2F	12.0					TFG-2F
590-2A	4.1					590-2A
590-2B	4.1					590-2B
591-2A	4.1					591-2A
592-2A	4.1					592-2A
593-2A	4.1					593-2A
594-2A	4.1					594-2A
618-2A	4.1					618-2A
618-2B	4.1					618-2B
619-2A	4.1					619-2A
620-2A	4.1					620-2A
621-2A	3.0					621-2A
622-2A	4.1					622-2A
622-2B	4.1					622-2B
623-2A	3.0					623-2A
624-2A	3.0					624-2A
705-2A	12.0					705-2A
706-2A	12.0					706-2A
707-2A	4.1					707-2A
708-2A	4.1					708-2A
709-2A	4.1					709-2A
710-2A	12.0					710-2A
711-2A	12.0					711-2A
712-2A	12.0					712-2A
713-2A	12.0					713-2A
714-2A	4.1					714-2A
714-2B	4.1					714-2B
715-2A	14.4					715-2A
716-2A	14.4					716-2A
717-2A	14.4					717-2A
718-2A	12.0					718-2A
719-2A	12.0					719-2A
801-2A	12.0		600	1590		801-2A
801-2B	15.4		530	1590		801-2B
802-2A	23.5		485	1600		802-2A
803-2A	23.5		465	1600		803-2A
804-2A	23.5		410	1600		804-2A
805-2A	23.5		470	1600		805-2A
806-2A	23.5		290	1200		806-2A

TCA OPERATING CONDITIONS (CONTINUED)

RUN NO.	EFFLU RES TIME MIN	TCA LOW PH TANK RES TIME MIN.	OXID AIR RATE SCFM	EDUCTOR CIRCUL RATE GPM	BLEED OXID TANK PH	RUN NO.
807-2A	23.5	2.9	475	1600		807-2A
808-2A	23.5	2.9	200	1600		808-2A
809-2A	15.7	1.9	300	1600		809-2A
810-2A	15.7	1.9	300	1600		810-2A
811-2A	23.5	2.9	270	1600		811-2A
812-2A	15.7	1.9	350	1600		812-2A
813-2A	23.5		310	1600		813-2A
814-2A	15.7		145	1200		814-2A
815-2A	14.4					815-2A
816-2A	14.4					816-2A
817-2A	14.4					817-2A
818-2A	14.4					818-2A
818-2B	14.4					818-2B
819-2A						819-2A
820-2A						820-2A
821-2A	4.1	4.1	170		5.35	821-2A

TCA ANALYTICAL RUN SUMMARY (GASES)

RUN NO.	AVG SO2 IN PPM	MIN SO2 IN PPM	MAX SO2 IN PPM	AVG SO2 OUT PPM	MIN SO2 OUT PPM	MAX SO2 OUT PPM	AVG SO2 REM %	MIN SO2 REM %	MAX SO2 REM %	AVG MAKE PER PASS MMOL /L	MIN MAKE PER PASS MMOL /L	MAX MAKE PER PASS MMOL /L	AVG O2 IN %	MIN O2 IN %	MAX O2 IN %	AVG BOIL LOAD MEGA WATT	MIN BOIL LOAD MEGA WATT	MAX BOIL LOAD MEGA WATT
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TFG-2A	3084	2640	3440	312	70	1340	89	56	97	14.5	10.1	16.3	9.1	7.9	10.2	145	124	150
TFG-2B	3274	2560	3600	409	120	700	86	76	95	15.0	12.9	16.9	8.1	5.8	9.5	126	93	150
TFG-2C	3260	2760	4080	570	360	1040	80	72	86	13.9	12.1	16.2	8.2	6.3	9.2	141	102	149
TFG-2D	3778	3160	4340	767	580	900	77	75	80	****	****	****	7.8	6.7	9.2	138	92	153
TFG-2E	3296	1180	4300	1525	1240	1940	41	-81	55	17.0	-10.3	22.8	7.4	4.5	8.5	147	125	151
TFG-2F	3000	2520	3840	724	500	1080	73	68	78	11.6	10.2	14.0	7.2	5.7	9.2	142	100	160
590-2A	2066	1960	2200	620	460	700	66	60	75	7.3	6.3	8.1	8.9	8.0	9.8	99	77	114
590-2B	2442	2000	2920	516	400	740	76	69	83	9.9	8.2	11.4				99	44	142
591-2A	2386	1240	3400	181	40	420	92	85	96	11.6	6.2	15.9				142	124	155
592-2A	2885	2280	3640	120	60	280	95	91	98	14.6	11.4	18.8	7.6	6.0	10.0	137	96	155
593-2A	2810	2400	3480	208	120	480	91	84	95	18.2	15.2	22.7	6.3	5.6	7.5	148	111	158
594-2A	2871	2080	3480	213	80	320	91	87	96	14.0	10.4	16.9	8.2	5.4	10.0	146	96	158
618-2A	2138	1520	3040	251	120	520	87	81	92	9.9	7.4	13.2				83	20	154
618-2B	1763	1240	2840	69	20	180	96	93	98	9.0	6.5	14.0	7.9	6.0	10.0	69	52	123
619-2A	1813	320	3460	107	5	510	94	84	99	9.0	1.6	15.3	9.3	8.1	10.0	73	58	116
620-2A	1692	640	3660	166	20	740	91	78	97	10.7	4.4	20.1	8.0	5.1	9.8	113	70	146
621-2A	2035	560	3080	83	10	200	96	93	99	10.3	2.9	15.1	8.8	7.0	10.0	85	68	149
622-2A	2606	2360	3000	208	70	360	91	87	97	16.8	14.6	19.2	8.0	6.0	10.0	128	98	156
622-2B	2554	2240	2840	380	220	560	83	77	89	15.1	14.1	16.6	7.3	4.2	10.0	133	96	156
623-2A	2563	2080	2880	212	60	400	90	83	97	12.3	10.7	14.0	8.1	6.2	10.0	123	96	154
624-2A	2841	2060	3320	462	90	680	82	77	95	16.4	13.9	19.6	7.1	2.5	8.5	140	94	157
705-2A	2812	2400	3320	394	200	540	84	79	91	12.6	10.8	15.4	10.3	9.1	12.0	144	106	162
706-2A	2772	2200	3600	466	280	760	81	73	88	11.9	9.7	15.0	10.2	7.0	12.5	143	100	152
707-2A	3007	2720	3680	759	600	1140	72	66	77	11.5	10.1	12.8	8.4	6.0	11.4	141	112	152
708-2A	3092	2760	3760	1449	1080	2020	48	40	58	7.9	7.1	8.9	7.0	5.8	8.2	144	129	152
709-2A	3314	2800	3720	1362	920	1620	54	47	64	9.6	8.5	11.2	9.0	8.0	11.8	130	93	159
710-2A	3431	2520	3920	1436	960	1840	53	47	64	9.7	8.3	10.8	6.8	5.3	10.5	136	59	156
711-2A	3284	2840	3680	1114	800	1360	62	58	69	10.9	10.3	11.5	7.0	7.0	7.0	148	146	150
712-2A	3028	2400	3320	836	540	1050	69	64	76	11.1	9.0	12.3	6.5	5.7	8.4	138	50	150
713-2A	2678	2200	3040	452	320	700	81	74	87	11.5	9.8	13.5	7.9	6.4	10.4	137	100	152
714-2A	2675	2040	3960	321	120	860	87	76	94	12.3	10.0	16.5	7.6	6.0	11.5	136	95	154
714-2B	3130	2720	3460	320	180	440	89	86	93				6.3	6.0	6.6	150	148	152
715-2A	2978	2480	3580	404	260	600	84	81	89	16.1	13.2	18.5	8.6	7.4	9.4	138	99	154
716-2A	2684	2060	3200	213	110	330	91	88	95	14.0	11.1	16.2	7.5	5.8	9.2	136	105	153
717-2A	2860	1800	3740	362	100	650	86	81	95				7.0	5.5	9.9	141	82	156
718-2A	3234	2760	3520	703	620	860	75	72	78	13.0	11.0	14.2	7.6	4.8	10.0	141	103	152
719-2A	3061	2740	3400	390	320	480	85	83	88	8.4	7.6	9.3	7.6	3.0	10.0	146	115	154
801-2A	2782	1920	3520	744	260	1140	71	64	85	10.4	8.3	11.9	9.7	9.6	9.8	109	95	149
801-2B	2810	2600	2920	825	680	900	67	66	71	10.0	9.8	10.2				133	115	148
802-2A	2888	2520	3200	624	540	700	75	73	80	11.6	9.9	13.0	7.5	6.0	8.5	126	84	149
803-2A	2820	1760	3080	985	420	1500	61	46	74	9.2	6.9	10.8	8.7	7.0	13.0	138	102	154
804-2A	3033	2440	3600	1016	480	1320	62	54	80	10.1	8.5	12.8	6.9	5.2	8.5	138	97	154
805-2A	3105	2800	3520	806	560	1280	71	60	80	11.7	9.9	13.7	7.7	6.2	9.0	125	86	153
806-2A	2965	2680	3680	807	680	1080	69	67	73	11.0	10.1	13.2	9.3	7.5	12.5	127	97	150

TCA ANALYTICAL RUN SUMMARY (GASES)

RUN NO.	AVG SO2 IN PPM	MIN SO2 IN PPM	MAX SO2 IN PPM	AVG SO2 OUT PPM	MIN SO2 OUT PPM	MAX SO2 OUT PPM	AVG SO2 REM %	MIN SO2 REM %	MAX SO2 REM %	AVG MAKE PER PASS MMOL /L	MIN MAKE PER PASS MMOL /L	MAX MAKE PER PASS MMOL /L	AVG O2 IN %	MIN O2 IN %	MAX O2 IN %	AVG BOIL LOAD MEGA WATT	MIN BOIL LOAD MEGA WATT	MAX BOIL LOAD MEGA WATT
807-2A	2643	2080	3320	416	160	700	83	76	91	11.6	8.8	13.5	7.6	6.2	8.5	133	96	153
808-2A	2862	2440	3520	773	400	1480	70	53	82	10.6	9.0	11.7	8.9	6.0	14.5	136	88	154
809-2A	3151	2480	3800	682	360	1100	76	60	85	12.7	8.2	14.0	6.7	5.5	8.0	119	94	152
810-2A	2940	2680	3200	463	280	860	82	70	88	12.9	11.7	14.0	8.2	6.5	11.0	138	94	155
811-2A	2747	2120	3320	334	200	560	86	81	90	12.6	10.0	14.3	7.1	5.5	8.5	126	92	154
812-2A	2996	2220	3840	513	300	960	81	71	87	12.9	10.0	15.3	8.2	7.5	9.5	142	95	154
813-2A	2898	2360	3280	536	380	760	79	74	83	12.2	9.4	13.6	7.5	5.6	8.6	145	116	155
814-2A	2589	2100	3080	616	380	840	73	68	82	10.1	6.3	12.3	9.5	8.5	12.5	135	95	154
815-2A	2897	2520	3160	263	200	400	90	86	92	16.6	14.6	17.5	7.4	6.5	8.5	151	140	155
816-2A	2871	2640	3000	251	140	360	90	87	94	16.5	15.8	17.1	7.2	6.6	8.0	131	106	151
817-2A	3050	2840	3200	580	500	680	78	76	82	10.2	9.7	10.8	6.7	2.8	10.0	131	92	154
818-2A	2988	2880	3080	421	390	500	84	82	86	13.4	12.7	14.0	6.7	3.0	10.0	144	120	156
818-2B	3320	2880	4100	547	420	760	81	79	84	14.4	12.6	17.3	7.2	3.0	9.9	148	132	155
819-2A	2742	2160	3060	573	330	800	76	69	86	8.9	7.6	10.1	9.3	6.5	12.2	119	8	152
820-2A	2438	1680	3120	445	130	1000	80	64	91	8.2	6.5	9.3				116	60	152
821-2A	2482	1560	2800	403	100	600	82	76	93	10.8	7.7	11.9	7.7	6.0	10.0	139	93	154

RUN SUMMARY - LIQUID ANALYTICAL DATA

CONCENTRATIONS IN LIQUID, PPM

RUN NO.	ANALYTICAL POINT	PH			CA++			MG++			SO3=			SO4=			CL-		
		AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX
TFG-2A	2816	5.41	5.21	5.67	238	133	440	10346	7639	12139	7889	3844	12213	27818	20544	34713	3284	2570	4121
	2825	5.23	4.90	5.62	316	159	618	10284	8079	12498	7653	4297	10856	28651	21314	37075	3374	2614	4431
TFG-2B	2816	5.75	5.62	5.83	1835	1425	2175	696	631	759	115	67	203	1909	962	2454	3769	3190	4343
	2825	5.19	4.77	5.45	1887	1590	2120	702	633	779	149	67	271	2026	927	2388	3790	3323	4387
TFG-2C	2816	5.85	5.71	6.11	1622	1055	2270	573	345	781	143	67	203	1371	617	2256	3421	2215	4631
	2825	5.30	5.38	5.75	1736	1185	2475	573	333	785	177	45	237	1752	1098	2702	3436	2304	4609
TFG-2D	2816	5.83	5.70	5.91	1394	1220	1710	466	330	539	89	33	158	1797	1306	2486	2546	1905	3080
	2825	5.38	5.16	5.53	1415	1255	1650	470	318	540	164	56	294	1925	1531	2697	2539	1772	3057
TFG-2E	2816	5.72	5.65	5.81	1146	885	1530	470	322	534	107	22	294	1153	554	2066	2536	2189	2969
	2825	5.07	4.95	5.27	1183	932	1545	487	431	569	236	45	644	1388	776	2269	2536	2233	2925
TFG-2F	2816	5.70	5.57	5.90	1633	1190	1990	563	465	647	80	33	158	1868	1121	2307	3317	2836	3944
	2825	5.19	5.00	5.44	1674	1160	2225	608	459	1089	163	33	441	1923	1103	2346	3502	2969	5983
590-2A	2816	5.07	4.94	5.16	1465	1350	1540	356	350	364	768	508	927	1827	1311	2174	1875	1772	1950
	2825	4.87	4.73	4.95	1521	1390	1650	316	306	325	942	848	1017	2160	1740	2389	1801	1772	1861
590-2B	2816	5.28	5.02	5.48	1455	1220	1670	389	304	450	251	113	395	1967	1733	2168	1858	1595	2039
	2825	5.07	4.82	5.33	1545	1315	1800	392	305	430	497	226	870	2014	1490	2290	1851	1595	1994
591-2A	2816	5.47	5.23	5.75	620	582	726	5372	4199	6209	2008	904	3222	19296	17036	21792	1400	1152	1905
	2825	5.30	5.07	5.67	674	588	780	5300	4399	5839	2773	1379	4127	18974	17052	21810	1414	1196	1959
592-2A	2816	5.40	5.10	5.64	605	419	762	9735	9199	10379	4376	3110	5880	31128	28443	34998	2526	2127	3589
	2825	5.18	4.92	5.41	660	435	868	9645	8819	10520	5095	2827	6729	30477	24186	35679	2550	2082	3816
593-2A	2816	5.45	5.20	5.70	556	400	734	10301	9480	11600	4536	2657	7803	31193	27359	36693	3819	3106	4482
	2825	5.24	5.00	5.80	619	408	842	10126	9000	11760	5595	3449	10404	30179	25876	36445	3853	3151	4748
594-2A	2816	5.36	5.10	5.60	557	352	664	10175	9400	10760	5371	1640	7859	30554	27392	33121	3574	3062	4571
	2825	5.14	4.90	5.40	650	384	834	10006	9060	10600	6420	2714	8255	30109	26761	33422	3648	3106	4659
618-2A	2816	6.97	6.40	7.67	1620	1500	1915	361	319	429	83	22	135	1985	1786	2214	2327	1861	2659
	2825	4.97	4.75	5.50	1924	1665	2175	373	337	414	861	271	1323	2435	1930	2650	2350	2171	2605
618-2B	2816	6.97	5.73	7.37	1551	1375	1905	382	347	444	83	11	169	1993	1787	2191	2400	2215	2659
	2825	5.76	5.16	8.20	1662	1350	2150	378	342	424	424	11	1017	2161	1994	2622	2381	2127	2659
619-2A	2816	6.94	5.21	8.08	569	100	708	3124	2599	3999	407	158	1492	10778	9210	12778	2155	1728	2481
	2825	5.77	5.14	7.00	696	116	960	3113	2579	4229	1103	214	1956	10842	9054	13642	2159	1772	2481
620-2A	2816	7.19	6.68	8.16	628	524	746	2733	2329	3289	330	248	418	9861	8865	11719	1883	1329	2393
	2825	5.84	4.79	7.36	727	580	810	2725	2349	3139	914	237	1922	10057	8308	12461	1882	1506	2393
621-2A	2816	7.04	6.65	7.75	660	528	850	2686	2139	3124	312	147	452	10185	8051	11437	1600	1285	2082
	2825	5.62	5.15	6.41	799	575	1090	2694	2229	3049	1025	294	2148	10084	3052	11814	1600	1240	2082
622-2A	2816	6.95	6.50	7.20	622	220	1076	5280	3310	8160	938	565	1470	17207	12019	26052	2236	1598	3239
	2825	5.54	5.20	6.70	724	292	1070	5274	3120	7780	2092	1018	2601	16801	11584	25066	2285	1598	3417
622-2B	2816	6.85	5.90	7.10	707	636	844	2665	2380	2960	465	113	1153	8852	8034	10044	1491	1331	1731
	2825	5.48	5.20	6.00	970	826	1052	2674	2230	3030	1301	498	1922	9137	8250	10158	1526	1287	1775
623-2A	2816	7.04	6.45	7.90	510	158	900	2742	2320	3400	411	181	746	9022	7740	11918	1616	1021	2130
	2825	5.37	4.70	5.79	670	356	1000	2671	2230	3370	1414	633	4071	8972	5848	11641	1616	932	2130
624-2A	2816	7.03	6.70	7.30	522	206	962	2641	2140	3180	478	204	882	7963	6799	9113	2014	1598	2840
	2825	5.16	4.90	5.60	861	330	1332	2587	2100	3160	1777	1221	2330	8205	6996	9595	2014	1598	2884

RUN SUMMARY - LIQUID ANALYTICAL DATA (CONTINUED)

RUN NO.	ANALYTICAL POINT	TOTAL IONS, PPM			PERCENT SULFATE SATURATION			PERCENT IONIC IMBALANCE		
		AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX
TFG-2A	2816	49720	39540	55236	37	17	77	-0.6	-9.8	8.4
	2825	50425	40606	59890	51	22	110	-2.7	-13.4	8.0
TFG-2B	2816	8414	7281	9826	102	51	141	1.9	-5.1	7.5
	2825	8642	7476	9688	109	49	130	1.3	-7.8	4.9
TFG-2C	2816	7219	4492	10118	76	35	128	2.3	-3.3	8.3
	2825	7763	525[illegible]	10885	99	64	156	-0.6	-5.2	2.5
TFG-2D	2816	6394	5746	7422	98	67	148	-0.2	-4.8	4.8
	2825	6614	6101	7493	105	80	162	-2.9	-10.3	0.4
TFG-2E	2816	5536	4332	6923	59	26	115	1.6	-7.5	8.9
	2825	5956	4895	7136	71	39	127	-2.9	-8.1	7.5
TFG-2F	2816	7609	5953	8719	102	55	133	-1.1	-13.6	5.5
	2825	8017	6277	12260	104	54	135	-2.9	-14.9	6.0
590-2A	2816	6407	5824	6839	109	79	129	-3.5	-6.8	-0.4
	2825	6861	6260	7267	132	106	148	-12.6	-15.0	-11.1
590-2B	2816	6037	5411	6661	113	104	127	7.9	-3.3	12.6
	2825	6414	5980	7310	118	94	130	5.4	-9.9	13.8
591-2A	2816	28837	24037	32605	104	92	123	-3.0	-8.8	3.7
	2825	29276	24892	32592	112	89	126	-6.3	-13.1	1.6
592-2A	2816	48479	44848	52378	105	73	138	0.7	-9.7	12.7
	2825	48534	43054	54977	113	64	158	-0.5	-14.3	13.2
593-2A	2816	50530	46318	57037	93	68	129	0.8	-8.9	14.8
	2825	50500	45671	59078	102	66	143	-1.1	-11.3	6.9
594-2A	2816	50354	46326	54018	92	59	112	-0.2	-5.8	8.8
	2825	50954	46367	56372	107	68	136	-3.5	-12.1	6.0
618-2A	2816	6497	6204	6974	121	110	136	4.6	-5.9	14.0
	2825	8064	7464	8691	154	133	170	-6.4	-14.5	5.2
618-2B	2816	6537	6262	7083	118	102	133	1.3	-5.1	13.7
	2825	7139	6224	8390	130	115	163	-3.9	-11.7	7.2
619-2A	2816	17162	14711	20696	85	15	114	-2.1	-15.1	5.9
	2825	18050	15700	21972	102	17	143	-6.6	-14.9	3.6
620-2A	2816	15559	13874	17797	94	82	116	-2.9	-10.6	9.2
	2825	16433	14966	18443	109	94	122	-8.1	-14.5	8.7
621-2A	2816	15578	12698	17498	103	74	128	-2.8	-12.9	11.3
	2825	16338	14344	18036	120	86	149	-5.7	-14.4	6.6
622-2A	2816	26374	18634	39655	97	36	170	4.4	-3.9	11.7
	2825	27269	19354	39455	109	47	170	0.6	-12.1	13.4
622-2B	2816	14263	13162	15290	98	88	114	7.3	-2.5	12.0
	2825	15693	13854	16566	132	116	149	1.7	-11.6	9.0
623-2A	2816	14391	12085	17876	72	23	130	3.8	-8.6	14.9
	2825	15432	12510	18705	94	52	148	-4.8	-14.2	9.2
624-2A	2816	13717	11883	16332	68	29	127	4.5	-10.9	12.4
	2825	15547	13782	17746	112	44	181	-5.9	-16.8	7.5

RUN SUMMARY - LIQUID ANALYTICAL DATA

CONCENTRATIONS IN LIQUID, PPM

RUN NO.	ANALYTICAL POINT	PH			CA++			MG++			SO3=			SO4=			CL-		
		AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX
705-2A	2816	5.85	5.66	5.95	1244	677	1875	633	524	714	139	45	384	1280	420	3029	2856	1861	3678
	2825	5.20	4.92	5.43	1277	689	1910	639	539	738	236	67	497	1304	284	3045	2902	1994	3722
706-2A	2916	5.55	5.17	6.00	1719	1320	2310	687	542	837	125	22	350	2301	1944	2754	3230	1728	4653
	2825	5.07	4.65	5.58	1798	1305	2330	703	556	831	234	45	859	2450	1867	3170	3323	2526	4431
707-2A	2816	5.59	5.43	5.79	1406	1125	2155	551	475	637	100	11	192	1904	1404	2421	2825	2082	4099
	2825	5.21	5.00	5.45	1426	1150	2070	548	479	655	121	11	226	1913	1470	2193	2854	2105	3855
708-2A	2816	5.21	5.02	5.40	1368	1190	1545	453	325	559	403	248	680	2222	1604	2805	1971	1598	2304
	2825	4.92	4.68	5.33	1534	1370	1790	470	331	575	829	463	1337	2380	1834	3333	2013	1644	2393
709-2A	2816	5.34	4.89	5.54	1229	1050	1405	411	345	449	311	45	633	2089	1821	2680	1671	1506	1905
	2825	4.97	4.63	5.12	1317	1075	1535	402	346	477	625	260	1121	2154	1836	2606	1700	1506	1950
710-2A	2816	5.41	5.16	5.77	1325	1060	1677	443	360	519	305	56	667	2087	1710	2659	1729	1063	2260
	2825	4.93	4.57	5.28	1459	1215	1700	441	285	524	725	350	995	2252	1569	2720	1686	1107	2149
711-2A	2816	5.65	5.43	5.83	1243	1020	1570	486	452	551	93	45	147	1524	1170	1979	2184	2038	2348
	2825	5.02	4.96	5.07	1587	1485	1690	472	467	478	158	158	158	1989	1979	1999	2270	2215	2326
712-2A	2816	5.85	5.64	6.04	991	618	1390	436	290	542	93	33	147	1273	741	2249	1990	1506	2304
	2825	5.16	5.00	5.40	1003	618	1445	427	299	561	134	56	271	1299	738	2156	1980	1373	2504
713-2A	2816	5.73	5.60	5.92	965	782	1300	372	307	416	133	22	452	1995	1610	2580	1146	886	1772
	2825	5.26	5.14	5.40	980	795	1252	375	306	440	149	33	260	2066	1634	2705	1152	797	1772
714-2A	2816	5.76	5.46	6.04	988	264	1540	493	288	642	164	56	437	1638	536	2775	1757	753	2623
	2825	5.31	3.62	5.79	1007	258	1685	481	258	699	166	45	316	1720	560	2747	1741	753	2597
714-2B	2916	6.13	6.03	6.19	306	260	374	254	189	392	120	22	178	551	359	722	761	531	1373
	2825	5.77	5.70	5.87	317	204	391	294	214	380	116	79	147	662	622	695	930	531	1418
715-2A	2816	5.74	5.52	5.98	1402	1095	1670	427	371	565	123	33	203	1800	1464	2085	2307	1595	3279
	2825	5.22	5.00	5.58	1414	1035	1717	415	365	499	192	67	357	1892	1532	2379	2223	1595	2836
716-2A	2816	5.72	5.53	5.95	1391	1180	1725	414	366	481	142	56	214	1963	1711	2114	2107	1595	2659
	2825	5.24	5.03	5.49	1424	1240	1755	414	357	496	211	113	452	2109	1831	2621	2099	1551	2535
717-2A	2816	5.90	5.58	6.12	1238	452	1905	441	329	696	135	45	260	1689	688	2661	2125	1347	3235
	2825	5.39	4.70	5.87	1260	459	1930	437	329	688	173	45	395	1758	713	2793	2095	1329	2969
718-2A	2816	5.79	5.62	5.95	1494	1165	1880	453	384	506	124	56	180	2001	1795	2324	2366	1905	3013
	2825																		
719-2A	2816	5.76	5.54	6.04	1130	1015	1263	415	369	519	166	79	260	2080	1933	2210	1524	1123	2127
	2825	5.24	5.02	5.49	1187	1012	1470	414	322	549	272	79	429	2177	1822	2380	1501	1196	1959
801-2A	2816	5.87	5.63	5.97	953	866	1080	372	277	448	109	45	237	2299	2133	2457	966	799	1462
	2825	5.21	4.89	5.66	1002	874	1106	368	306	435	319	79	678	2457	2149	2665	932	799	1119
801-2B	2816	5.74	5.46	5.90	987	930	1065	378	357	420	180	102	351	2133	1959	2400	1137	1063	1287
	2825	5.09	4.95	5.29	1150	1070	1260	361	307	392	595	362	1074	2326	2223	2446	1132	975	1287
802-2A	2816	5.78	5.71	5.97	1068	1010	1200	382	332	490	101	34	158	1987	1880	2285	1469	1321	1677
	2825	5.07	4.95	5.29	1153	1068	1255	382	321	486	331	204	452	2207	1805	2541	1454	1331	1598
803-2A	2816	5.05	4.71	5.29	1159	1030	1355	478	409	555	141	33	463	2164	1867	2665	1850	1750	1994
	2825	3.79	3.29	4.33	1252	1087	1470	477	413	561	510	180	1085	2267	1919	2522	1840	1684	2038
804-2A	2816	5.06	4.85	5.33	1344	920	1930	553	459	630	64	11	158	2079	1685	2467	2319	1573	3368
	2825	3.86	3.29	4.65	1469	1067	2190	556	423	639	351	79	678	2347	1760	2828	2353	1595	3722

RUN SUMMARY - LIQUID ANALYTICAL DATA (CONTINUED)

RUN NO.	ANALYTICAL POINT	TOTAL IONS, PPM			PERCENT SULFATE SATURATION			PERCENT IONIC IMBALANCE		
		AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX
705-2A	2816	6200	4246	8537	62	16	162	4.5	-4.7	14.9
	2825	6406	4349	8892	64	11	166	2.6	-8.1	14.1
706-2A	2816	8125	6102	9996	118	97	153	1.6	-12.9	15.0
	2825	8572	7216	10049	126	99	155	-0.7	-13.8	10.4
707-2A	2816	6848	5634	9417	98	66	147	-3.4	-12.3	2.5
	2825	6926	5729	8862	99	70	134	-4.1	-11.6	1.7
708-2A	2816	6515	5508	6951	118	86	143	-3.0	-12.0	3.4
	2825	7325	6529	8225	130	103	177	-7.3	-14.2	-1.8
709-2A	2816	5813	5142	6519	109	88	143	-0.3	-10.4	14.0
	2825	6305	5187	7530	117	90	142	-6.3	-14.9	10.1
710-2A	2816	5994	4836	6894	110	84	131	5.9	-7.1	19.2
	2825	6667	5132	7601	124	89	149	0.1	-6.6	12.1
711-2A	2816	5636	5002	6369	79	57	107	9.2	2.4	13.0
	2825	6576	6435	6718	113	110	116	9.9	7.5	12.2
712-2A	2816	4890	3414	6362	62	33	118	4.0	-10.7	16.4
	2825	4949	3249	6889	64	36	110	2.8	-9.5	16.0
713-2A	2816	4664	3960	5689	96	73	136	4.2	-5.0	11.3
	2825	4777	4041	5816	100	75	141	3.0	-10.0	11.8
714-2A	2816	5209	2016	6849	75	17	124	8.0	-12.5	14.2
	2825	5284	1933	7538	80	18	141	6.5	-10.4	13.7
714-2B	2816	2075	1585	3011	19	13	27	9.0	0.5	17.2
	2825	2415	1710	3082	21	18	26	1.2	-6.4	10.0
715-2A	2816	6175	5015	7436	100	75	118	3.1	-2.9	13.7
	2825	6257	5071	7313	106	80	133	1.8	-5.8	14.4
716-2A	2816	6128	5474	6906	109	101	121	3.1	-2.3	12.5
	2825	6368	5850	6992	117	105	136	0.3	-11.4	10.6
717-2A	2816	5744	3976	7423	89	18	145	3.4	-8.2	14.2
	2825	5838	3866	7720	93	18	170	2.4	-14.4	14.9
718-2A	2816	6565	6019	7441	111	101	132	3.6	-11.5	11.6
	2825									
719-2A	2816	5412	5002	6120	104	96	115	3.2	-14.7	14.5
	2825	5650	5088	6448	111	93	129	1.9	-14.4	11.7
801-2A	2816	4795	4517	5373	108	95	120	3.9	-12.8	12.9
	2825	5179	4790	5844	118	102	136	-2.5	-14.7	4.6
801-2B	2816	4908	4654	5335	103	98	114	2.8	-4.0	11.2
	2825	5657	5375	6327	121	116	127	-5.7	-11.6	-1.2
802-2A	2816	5098	4800	5685	100	94	107	2.6	-2.9	10.6
	2825	5623	4865	6263	114	94	134	-3.3	-10.9	6.9
803-2A	2816	5899	5501	6543	104	87	126	-0.1	-10.5	7.5
	2825	6455	5983	7039	113	93	129	-6.2	-12.0	4.1
804-2A	2816	6503	5377	7711	101	96	112	5.4	-6.5	13.7
	2825	7219	5816	8533	118	95	137	-0.8	-14.8	13.8

RUN SUMMARY - LIQUID ANALYTICAL DATA

CONCENTRATIONS IN LIQUID, PPM

RUN NO.	ANALYTICAL POINT	PH			CA++			MG++			SO3=			SO4=			CL-		
		AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX
805-2A	2816	5.30	4.74	5.57	1122	940	1470	539	372	639	188	11	474	2334	2078	2606	1581	1307	2087
	2825	4.59	4.03	4.98	1297	1017	1687	551	452	650	647	294	1062	2676	2182	3090	1574	1307	2127
806-2A	2816	5.35	5.25	5.49	1340	1105	1565	519	439	610	433	192	701	2186	1966	2353	1961	1506	2393
	2825	4.82	4.70	4.92	1461	1175	1732	543	471	594	872	576	1153	2244	1984	2732	1905	1462	2393
807-2A	2816	5.47	5.16	5.81	1282	957	1605	510	470	591	123	0	361	1948	1669	2452	2116	1506	2880
	2825	4.80	3.78	5.04	1479	1250	1900	496	340	560	462	11	1017	2327	1784	2974	2089	1462	2925
808-2A	2816	5.11	4.91	5.27	1832	1570	2105	513	416	594	622	22	1967	2111	1689	2859	2922	2260	3456
	2825	4.71	4.45	4.96	2026	1740	2250	524	452	620	1104	316	2046	2263	1623	2797	2919	2260	3589
809-2A	2816	5.24	5.02	5.81	1725	1400	1945	646	549	733	447	33	949	2194	1696	2692	2957	2659	3235
	2825	4.73	4.52	5.04	1921	1535	2165	631	499	754	970	350	1583	2427	1391	2891	2988	2792	3279
810-2A	2816	5.44	4.83	5.71	1585	1395	1785	754	562	904	95	5	531	2283	2017	2614	3052	2747	3323
	2825	4.83	4.07	5.25	1780	1445	2195	750	629	882	567	248	1402	2531	1942	2958	3013	2792	3213
811-2A	2816	5.83	5.60	6.06	966	777	1152	393	288	562	62	11	169	2166	1722	2778	1303	952	1861
	2825	5.16	4.86	5.69	1129	900	1325	392	254	452	427	101	993	2563	1783	3262	1268	842	1905
812-2A	2816	5.57	5.33	5.87	1155	897	1387	406	335	499	155	33	723	2015	1763	2549	1712	1196	2348
	2825	5.09	4.86	5.67	1354	1085	1592	416	307	528	637	158	1605	2209	1068	2707	1694	1240	2260
813-2A	2816	5.34	5.19	5.45	1085	927	1395	394	178	637	91	22	452	1807	1295	2026	1657	1063	2614
	2825	4.59	4.24	4.73	1229	1085	1577	351	201	439	530	316	1130	1898	634	2581	1495	1107	2082
814-2A	2816	5.36	5.16	5.75	1226	1060	1352	411	372	517	432	180	904	2218	1792	2858	1655	1418	1950
	2825	4.98	4.70	5.40	1308	1125	1490	402	381	442	737	327	1187	2133	1678	2663	1635	1240	1905
815-2A	2816	6.26	6.00	6.41	1227	1050	1470	458	395	529	126	90	158	2128	1962	2239	1564	1285	1950
	2825	5.33	5.19	5.46	1254	1040	1530	439	389	524	222	135	395	2231	2128	2414	1442	1152	1950
816-2A	2816	6.26	6.04	6.42	1026	980	1120	415	379	472	90	11	158	2084	1902	2217	1233	1107	1373
	2825	5.36	5.16	5.61	1068	1035	1120	433	389	469	272	22	588	2133	1953	2307	1211	1063	1329
817-2A	2816	5.84	5.79	5.89	1053	945	1260	406	367	441	155	67	350	2096	1909	2270	1311	1107	1506
	2825	5.23	4.99	5.54	1209	1090	1385	388	324	454	470	119	802	2311	1921	2719	1294	1152	1506
818-2A	2816	6.17	5.99	6.35	1115	1035	1200	453	360	543	111	67	203	1994	1797	2141	1545	1373	1728
	2825	5.43	5.25	5.61	1150	1070	1290	437	363	490	211	101	361	2039	1810	2281	1491	1373	1684
818-2B	2816	6.14	5.50	6.40	1180	1035	1475	464	403	612	112	56	180	2211	2015	2341	1556	1373	1772
	2825	5.43	5.23	5.67	1189	1050	1525	449	333	590	223	99	373	2164	2008	2336	1528	1373	1861
819-2A	2816	5.57	5.07	6.07	1300	1080	1530	379	326	430	329	11	1153	2055	1777	2728	1628	1376	1950
	2825	5.17	4.36	5.48	1433	1130	1725	380	324	425	669	45	1673	2195	1626	2866	1596	1331	1905
820-2A	2816	5.68	5.29	6.06	1411	1200	1725	369	320	617	260	22	915	2006	1550	2474	1808	1595	2969
	2825	5.33	5.00	5.60	1548	1335	1900	363	318	406	597	204	1277	2129	1585	2632	1772	1551	2171
821-2A	2816	5.34	5.10	5.90	640	488	874	5852	4820	6360	1496	90	2895	20731	17395	24153	2605	1819	3905
	2825	5.12	4.90	5.50	684	530	924	5928	4650	6470	2030	656	3573	20482	17099	24080	2615	1775	3861

RUN SUMMARY - LIQUID ANALYTICAL DATA (CONTINUED)

RUN NO.	ANALYTICAL POINT	TOTAL IONS, PPM			PERCENT SULFATE SATURATION			PERCENT IONIC IMBALANCE		
		AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX
805-2A	2816	5931	5420	6909	104	90	124	7.6	0.7	11.3
	2825	6907	6323	7891	126	104	142	-0.6	-6.0	3.6
806-2A	2816	6580	5650	7334	110	93	127	2.7	-8.9	13.4
	2825	7161	6343	8063	115	104	132	0.3	-7.6	7.7
807-2A	2816	6137	5594	6857	97	90	114	7.1	-6.0	14.6
	2825	7010	6158	8044	123	101	149	0.8	-6.5	11.4
808-2A	2816	8167	7729	8991	123	98	152	-1.9	-13.5	4.7
	2825	9005	8389	9819	135	106	161	-4.7	-14.1	5.8
809-2A	2816	8173	7234	9448	116	94	144	4.2	-9.4	13.6
	2825	9141	8004	10408	134	85	166	-2.8	-13.2	14.8
810-2A	2816	7975	7440	8474	109	93	127	8.1	-6.6	14.8
	2825	8851	8117	9433	127	99	161	3.4	-13.3	14.0
811-2A	2816	5016	4591	5485	102	90	139	1.3	-10.0	12.2
	2825	5904	5380	6424	127	93	158	-7.7	-14.5	2.7
812-2A	2816	5547	5029	7082	103	89	130	2.0	-7.5	9.8
	2825	6412	5312	7302	119	66	140	-3.5	-13.8	14.9
813-2A	2816	5145	4063	6535	92	76	119	3.6	-13.8	11.6
	2825	5613	4285	6772	103	41	139	-0.7	-12.1	11.5
814-2A	2816	6067	5307	6610	115	99	148	-4.2	-14.5	8.9
	2825	6334	5662	7200	115	100	138	-6.2	-14.3	6.4
815-2A	2816	5608	5227	6203	107	99	116	10.4	2.5	13.9
	2825	5692	5317	6475	114	101	127	9.0	1.2	12.7
816-2A	2816	4947	4874	5095	100	91	107	9.1	2.5	14.4
	2825	5214	5054	5414	103	95	115	7.2	1.2	13.8
817-2A	2816	5123	4807	5463	102	94	115	5.2	0.0	12.8
	2825	5775	5232	6363	120	109	135	-1.0	-9.8	8.8
818-2A	2816	5323	4858	5643	97	83	105	8.8	3.1	12.2
	2825	5436	5160	5789	102	93	115	7.3	3.3	14.9
818-2B	2816	5634	5296	6123	109	99	124	7.7	2.3	14.6
	2825	5658	5425	5851	108	95	134	5.8	-4.9	14.0
819-2A	2816	5794	5027	6744	113	97	131	2.5	-13.0	14.0
	2825	6380	5356	7624	124	85	159	-1.2	-11.2	14.7
820-2A	2816	5967	5100	7691	115	89	146	5.2	-5.5	13.8
	2825	6519	5647	7621	126	104	155	1.5	-14.7	14.8
821-2A	2816	31465	25298	33673	108	92	156	-4.8	-14.1	4.6
	2825	31881	25238	34807	113	91	158	-4.7	-10.4	2.9

RUN SUMMARY - SOLIDS ANALYTICAL DATA

CONCENTRATIONS IN SOLIDS, WT %

RUN NO.	ANALYTICAL POINT	CO2			SO2			SO3			CAO			ACID INSOLUBLES			SOLIDS IN SLURRY, WT %		
		AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX
TFG-2A	2816	5.52	3.11	9.02	24.10	19.54	28.99	4.67	0.98	8.11	31.79	29.42	35.49	3.04	2.63	3.53	15.8	13.5	18.9
TFG-2B	2816	7.91	1.74	14.55	20.53	14.69	27.65	4.38	0.65	8.84	31.93	24.66	37.29	4.09	3.47	4.76	15.4	14.4	16.7
TFG-2C	2816	3.93	2.51	6.58	23.88	15.92	27.69	3.71	1.50	5.92	28.96	21.95	32.27	5.50	4.98	6.25	15.4	14.5	16.7
TFG-2D	2816	3.83	2.80	6.49	23.95	19.54	26.42	3.67	0.19	5.72	29.33	26.30	31.17	3.88	3.72	3.99	14.0	12.8	19.5
TFG-2E	2816	3.71	2.72	5.47	21.64	18.09	24.31	3.65	0.46	7.74	27.30	25.24	29.27	5.18	4.19	6.08	14.5	12.6	15.1
TFG-2F	2816	3.93	2.82	4.78	23.14	19.54	29.31	5.60	2.26	10.18	29.72	25.56	33.20	4.37	3.37	5.37	15.1	12.9	16.2
590-2A	2816	1.55	1.19	1.98	10.09	9.04	11.58	9.95	7.99	12.63	17.78	17.32	18.32	6.86	6.56	7.12	13.8	13.2	14.5
590-2B	2816	2.58	1.24	4.51	14.58	12.55	17.01	8.32	7.05	11.67	22.03	19.25	23.89	5.59	4.73	6.86	14.5	13.5	15.9
591-2A	2816	4.40	2.29	7.92	12.35	4.47	18.42	11.85	6.99	20.30	24.02	18.74	27.77	5.33	4.20	6.21	14.4	13.1	15.9
592-2A	2816	7.50	4.45	10.69	16.31	12.90	23.88	6.56	0.01	12.75	27.53	24.20	30.92	5.43	4.52	7.19	15.1	14.0	17.0
593-2A	2816	9.72	5.20	13.30	14.92	11.10	20.20	6.15	3.25	8.33	28.92	22.10	31.90	5.14	4.30	6.40	15.0	13.2	17.8
594-2A	2816	5.58	3.90	6.60	19.07	14.80	22.80	5.31	3.20	7.68	26.60	23.70	29.60	5.59	5.20	6.70	15.1	13.9	16.2
618-2A	2816	1.18	0.77	2.07	16.84	13.66	22.19	7.89	4.99	11.25	21.97	19.70	25.07	3.00	2.33	3.87	7.9	6.5	10.0
618-2B	2816	0.96	0.44	1.42	16.06	12.25	20.52	8.56	4.46	11.04	22.00	18.80	25.95	2.76	1.82	3.79	7.5	6.3	8.7
619-2A	2816	0.78	0.27	1.98	20.12	14.96	25.33	7.43	2.73	14.34	24.48	19.02	29.31	2.72	1.76	4.07	8.0	6.9	9.5
620-2A	2816	0.88	0.38	1.31	19.00	14.69	21.71	9.21	7.68	10.96	25.39	22.83	27.28	2.52	1.87	3.14	8.5	6.2	10.1
621-2A	2816	0.82	0.10	4.16	17.21	12.30	20.50	8.47	6.00	11.16	22.26	18.81	27.98	3.29	1.88	4.21	8.1	6.3	9.2
622-2A	2816	1.36	0.90	2.30	21.04	16.00	25.30	7.45	4.85	11.55	24.91	21.90	27.80	3.14	2.80	3.60	8.6	7.7	10.1
622-2B	2816	0.99	0.10	2.50	19.42	15.00	21.30	3.81	1.35	5.50	21.40	16.50	24.20	3.56	2.90	5.30	8.0	7.3	9.2
623-2A	2816	1.32	0.10	5.10	22.51	18.40	28.60	4.38	1.00	8.20	23.93	19.90	26.90	3.21	2.50	4.20	8.2	7.4	9.3
624-2A	2816	0.64	0.30	1.30	20.69	17.90	24.90	4.39	-0.70	8.28	22.34	19.90	25.50	3.45	2.80	4.20	8.0	7.0	9.2

RUN SUMMARY - SOLIDS ANALYTICAL DATA (CONTINUED)

RUN NO.	ANALYTICAL POINT	PERCENT SULFITE OXIDATION			STOICHIOMETRIC RATIO			PERCENT IONIC IMBALANCE		
		AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX
TFG-2A	2816	13.2	3.4	22.0	1.31	1.15	1.59	1.2	-4.4	5.0
TFG-2B	2816	14.2	3.0	25.5	1.56	1.08	2.20	2.5	-2.9	8.3
TFG-2C	2816	11.1	4.2	16.4	1.22	1.12	1.50	1.3	-8.5	7.3
TFG-2D	2816	10.9	0.7	19.0	1.21	1.14	1.37	3.1	-1.7	6.4
TFG-2E	2816	11.6	1.7	24.6	1.22	1.15	1.31	4.0	-1.3	7.5
TFG-2F	2816	16.2	7.9	27.9	1.21	1.15	1.25	1.8	-3.2	8.2
590-2A	2816	43.9	35.6	52.8	1.13	1.09	1.17	-0.1	-0.8	0.4
590-2B	2816	31.3	24.9	37.8	1.18	1.09	1.35	0.6	-4.6	7.4
591-2A	2816	43.8	25.3	75.2	1.30	1.18	1.61	-2.8	-6.6	2.7
592-2A	2816	23.1	0.0	44.0	1.55	1.24	2.16	-3.8	-7.9	3.5
593-2A	2816	25.2	13.9	37.5	1.74	1.39	2.16	-2.9	-8.4	7.8
594-2A	2816	18.4	11.0	25.8	1.35	1.23	1.46	-3.6	-7.9	5.1
618-2A	2816	27.5	15.2	39.7	1.08	1.05	1.15	0.8	-4.9	7.3
618-2B	2816	30.1	15.5	38.8	1.06	1.03	1.08	3.1	-4.7	8.5
619-2A	2816	22.7	8.4	42.7	1.05	1.01	1.12	2.6	-5.8	7.7
620-2A	2816	28.2	22.1	37.0	1.05	1.02	1.07	4.7	0.9	8.3
621-2A	2816	28.3	20.0	41.3	1.05	1.01	1.26	0.8	-7.1	8.0
622-2A	2816	22.3	13.8	35.8	1.08	1.04	1.15	-1.8	-6.2	4.5
622-2B	2816	13.6	4.9	18.7	1.06	1.01	1.16	2.0	-7.3	8.4
623-2A	2816	13.5	3.5	25.1	1.08	1.01	1.31	-2.2	-7.8	4.6
624-2A	2816	14.4	-2.5	25.6	1.04	1.02	1.07	1.6	-6.7	8.2

RUN SUMMARY - SOLIDS ANALYTICAL DATA

CONCENTRATIONS IN SOLIDS, WT %

RUN NO.	ANALYTICAL POINT	CO2 AVG	CO2 MIN	CO2 MAX	SO2 AVG	SO2 MIN	SO2 MAX	SO3 AVG	SO3 MIN	SO3 MAX	CAO AVG	CAO MIN	CAO MAX	ACID INSOLUBLES AVG	ACID INSOLUBLES MIN	ACID INSOLUBLES MAX	SOLIDS IN SLURRY, WT % AVG	SOLIDS IN SLURRY, WT % MIN	SOLIDS IN SLURRY, WT % MAX
705-2A	2816	2.92	0.93	5.28	36.21	23.52	40.36	6.87	0.93	22.84	41.42	36.68	47.01	0.62	0.20	1.07	14.7	9.6	15.9
706-2A	2816	3.67	1.26	7.93	33.33	27.14	36.91	9.81	1.44	19.60	40.53	35.44	44.59	1.09	0.19	7.05	14.6	13.5	16.0
707-2A	2816	4.00	2.88	5.06	21.85	18.09	24.25	5.25	4.19	9.42	28.81	24.62	31.54	4.71	3.62	5.50	14.9	13.5	15.7
708-2A	2816	2.66	1.25	4.07	19.73	15.84	23.13	5.10	2.13	13.32	25.23	22.13	28.98	5.75	4.48	6.50	15.1	14.1	15.9
709-2A	2816	3.00	1.48	4.75	20.22	17.30	23.52	6.74	1.90	12.82	27.34	25.00	30.71	4.70	4.32	5.08	14.1	13.1	14.9
710-2A	2816	2.99	1.82	5.67	21.45	16.32	27.73	4.40	0.07	10.74	26.62	23.09	30.58	5.17	4.82	5.46	14.7	13.0	15.6
711-2A	2816	4.47	2.36	5.62	22.39	19.12	26.06	4.48	1.59	7.31	29.37	25.55	33.86	5.04	4.26	6.43	14.3	9.0	15.9
712-2A	2816	4.01	2.66	5.34	22.99	18.35	26.06	6.19	1.61	12.12	30.11	28.08	31.74	4.35	3.89	4.98	15.0	13.0	16.3
713-2A	2816	5.05	3.61	6.93	21.50	18.50	24.61	6.10	3.91	9.17	28.88	25.97	30.99	4.58	4.12	4.86	14.9	13.9	16.5
714-2A	2816	6.41	3.53	8.80	20.01	13.87	24.97	4.82	-0.54	14.35	29.91	23.17	36.16	4.37	0.44	6.24	15.2	14.1	16.5
714-2B	2816	9.58	8.74	10.41	21.08	20.23	22.74	1.11	0.21	1.73	32.59	31.20	34.78	3.78	3.78	3.78	15.3	14.2	17.0
715-2A	2816	3.67	1.94	4.82	20.05	16.54	26.00	6.52	4.26	9.12	27.06	24.62	28.89	4.93	4.11	5.86	15.0	14.2	15.7
716-2A	2816	2.88	0.20	6.29	20.59	16.48	23.96	8.40	5.19	12.43	27.28	25.25	29.41	4.66	3.98	5.57	14.4	13.0	15.5
717-2A	2816	4.52	2.03	7.82	21.24	12.83	26.40	6.73	3.03	16.38	28.80	22.31	33.57	4.39	2.92	6.48	14.8	13.1	22.4
718-2A	2816	5.37	2.97	8.16	18.76	14.24	23.88	6.43	3.10	8.95	27.34	24.98	29.10	4.70	3.69	5.54	14.3	13.1	15.3
719-2A	2816	2.68	0.55	4.96	20.85	18.13	24.25	6.36	4.16	10.86	26.36	24.62	28.49	4.76	4.04	5.37	14.8	13.5	16.7
801-2A	2816	3.40	1.32	6.20	10.84	7.39	13.74	14.98	10.39	18.61	24.31	21.41	26.86	5.05	4.79	5.30	14.5	12.9	15.4
801-2B	2816	3.42	2.03	4.60	7.44	4.82	11.94	15.32	11.72	19.09	21.88	19.47	24.69	5.06	4.77	5.35	14.7	12.3	16.0
802-2A	2816	2.98	1.87	4.03	9.08	6.09	10.69	14.26	10.11	17.25	22.16	20.20	24.69	5.18	4.88	5.43	15.3	14.5	16.0
803-2A	2816	0.48	0.15	0.87	1.29	0.59	2.12	15.24	4.99	25.84	12.65	5.80	20.27	7.54	4.94	10.83	15.1	14.1	16.4
804-2A	2816	0.63	0.15	1.88	0.82	0.00	1.44	14.80	3.40	29.77	12.10	2.89	24.00	8.12	5.35	10.96	15.1	13.3	17.0

RUN SUMMARY - SOLIDS ANALYTICAL DATA (CONTINUED)

RUN NO.	ANALYTICAL POINT	PERCENT SULFITE OXIDATION			STOICHIOMETRIC RATIO			PERCENT IONIC IMBALANCE		
		AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX
705-2A	2816	12.8	1.8	43.7	1.10	1.03	1.21	2.9	-8.1	7.9
706-2A	2816	18.9	3.3	36.3	1.13	1.04	1.35	-0.5	-7.6	8.4
707-2A	2816	16.2	12.8	28.6	1.23	1.16	1.31	3.1	-0.9	6.8
708-2A	2816	16.6	7.5	40.1	1.16	1.08	1.23	4.0	-1.2	8.2
709-2A	2816	20.6	6.2	35.1	1.18	1.08	1.32	4.0	0.2	7.1
710-2A	2816	13.9	0.2	34.5	1.18	1.10	1.40	3.5	-7.6	8.3
711-2A	2816	13.9	4.8	22.9	1.25	1.13	1.33	3.1	-1.5	7.9
712-2A	2816	17.7	4.8	34.6	1.21	1.13	1.31	1.8	-3.4	8.3
713-2A	2816	18.4	12.6	25.3	1.28	1.19	1.44	-2.3	-8.5	5.0
714-2A	2816	15.1	-1.9	33.2	1.41	1.15	1.65	2.9	-4.5	7.4
714-2B	2816	3.9	0.8	6.4	1.64	1.59	1.68	3.6	1.8	5.2
715-2A	2816	20.7	13.2	29.1	1.22	1.09	1.30	1.0	-7.1	7.6
716-2A	2816	24.5	16.0	34.3	1.16	1.01	1.41	-1.2	-8.5	7.0
717-2A	2816	20.4	8.5	45.2	1.25	1.10	1.55	-1.0	-7.8	8.5
718-2A	2816	21.6	11.1	31.8	1.34	1.16	1.53	-1.7	-8.3	8.1
719-2A	2816	19.6	13.4	30.8	1.15	1.03	1.33	0.8	-5.1	7.5
801-2A	2816	52.5	37.7	65.5	1.22	1.08	1.42	-0.1	-5.3	7.8
801-2B	2816	62.8	48.1	72.3	1.27	1.13	1.47	1.2	-3.9	6.7
802-2A	2816	55.6	42.9	68.7	1.22	1.12	1.30	1.9	-3.6	7.5
803-2A	2816	88.7	65.6	96.6	1.06	1.01	1.21	1.7	-8.4	8.3
804-2A	2816	93.0	79.5	100.0	1.07	1.03	1.15	1.5	-7.7	8.4

RUN SUMMARY - SOLIDS ANALYTICAL DATA

CONCENTRATIONS IN SOLIDS, WT %

RUN NO.	ANALY TICAL POINT	CO2			SO2			SO3			CAO			ACID INSOLUBLES			SOLIDS IN SLURRY, WT %		
		AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX
805-2A	2816	1.80	0.24	5.33	1.16	0.15	6.81	17.64	6.70	28.01	16.07	9.76	24.60	6.55	5.25	9.69	15.1	13.8	16.7
806-2A	2816	1.52	0.48	3.36	8.30	4.70	13.60	14.37	9.84	21.67	19.67	16.58	22.74	6.15	5.88	6.30	14.4	13.5	15.0
807-2A	2816	2.56	0.83	4.40	0.68	0.00	1.80	19.60	13.75	25.43	17.47	11.18	23.97	5.55	4.14	7.22	14.8	13.5	16.0
808-2A	2816	5.72	3.37	7.46	1.07	0.17	2.53	16.46	6.73	28.25	19.78	13.11	30.10	5.00	3.86	5.57	14.9	12.6	16.1
809-2A	2816	8.61	7.53	10.23	0.78	0.26	2.35	23.54	15.41	35.18	29.03	24.17	35.52	5.21	4.14	5.86	15.6	14.0	17.1
810-2A	2816	4.25	0.99	6.75	0.68	0.09	2.89	25.54	22.07	32.94	23.45	18.37	30.36	3.91	3.12	4.76	15.1	13.7	17.5
811-2A	2816	7.75	4.18	9.82	0.84	0.32	2.17	18.93	12.96	26.57	23.49	19.82	25.55	4.33	3.21	5.21	14.8	13.5	15.9
812-2A	2816	7.45	5.06	12.21	1.13	0.31	2.15	16.32	6.35	20.89	22.29	15.04	27.14	5.63	3.67	9.07	14.4	10.9	16.7
813-2A	2816	1.54	0.93	3.22	0.94	0.17	1.80	22.11	4.52	27.68	17.81	5.52	20.70	6.23	4.07	11.47	14.9	14.1	15.5
814-2A	2816	1.92	0.73	4.16	7.31	2.62	11.03	14.97	10.53	17.95	18.54	15.67	26.36	6.49	5.73	7.84	14.7	14.3	15.0
815-2A	2816	3.86	2.53	5.79	14.82	11.93	17.39	12.09	7.79	15.75	26.02	23.79	27.72	4.84	4.07	5.31	14.9	14.2	15.6
816-2A	2816	4.70	3.74	5.69	10.22	8.44	13.04	13.59	9.80	15.44	24.24	23.36	25.74	5.19	4.80	6.07	15.2	13.8	16.0
817-2A	2816	2.93	1.87	3.74	1.18	0.28	3.44	22.31	13.25	24.83	20.14	13.64	22.59	5.25	3.97	8.08	14.6	13.2	17.7
818-2A	2816	4.30	3.19	5.58	7.21	4.70	9.23	17.91	14.39	21.04	25.17	23.41	26.44	4.82	3.87	6.11	14.9	14.1	16.3
818-2B	2816	4.26	2.19	5.87	19.80	17.01	22.86	7.71	5.35	10.87	28.42	25.53	31.34	4.16	3.57	4.68	14.3	13.4	15.3
819-2A	2816	3.92	1.48	6.57	1.17	0.18	2.76	21.72	17.71	26.51	21.20	15.67	26.43	4.70	2.99	6.53	12.9	10.7	14.7
820-2A	2816	6.96	3.45	9.79	1.30	0.36	2.17	18.44	10.11	22.36	23.34	13.20	26.86	4.77	2.97	7.02	13.8	11.7	15.6
821-2A	2816	3.66	1.00	9.60	0.86	0.20	2.10	20.89	10.48	27.23	19.53	14.50	24.20	6.76	5.20	11.50	14.9	13.4	16.1

RUN SUMMARY - SOLIDS ANALYTICAL DATA (CONTINUED)

RUN NO.	ANALYTICAL POINT	PERCENT SULFITE OXIDATION AVG	MIN	MAX	STOICHIOMETRIC RATIO AVG	MIN	MAX	PERCENT IONIC IMBALANCE AVG	MIN	MAX
805-2A	2816	92.0	69.3	98.8	1.23	1.02	2.20	2.5	-5.3	7.1
806-2A	2816	58.0	36.7	78.7	1.12	1.03	1.26	2.0	-8.2	5.8
807-2A	2816	96.1	91.3	100.0	1.23	1.09	1.37	-0.7	-8.2	4.6
808-2A	2816	91.8	81.9	99.1	1.63	1.37	2.26	0.3	-8.1	7.5
809-2A	2816	96.1	86.8	98.5	1.68	1.44	2.08	3.1	-3.7	8.5
810-2A	2816	96.9	90.1	99.5	1.31	1.06	1.49	-2.1	-7.8	6.5
811-2A	2816	94.4	82.7	98.3	1.74	1.28	2.08	-1.8	-8.0	7.4
812-2A	2816	92.2	85.1	97.5	1.89	1.44	3.32	1.4	-8.1	8.4
813-2A	2816	94.3	85.2	99.1	1.15	1.06	1.60	-2.9	-7.8	8.4
814-2A	2816	62.9	48.7	84.6	1.15	1.05	1.36	-4.3	-7.4	-0.9
815-2A	2816	39.3	29.8	49.8	1.23	1.14	1.35	-1.3	-7.6	4.5
816-2A	2816	51.6	37.6	58.9	1.33	1.25	1.42	-0.9	-6.0	3.6
817-2A	2816	93.9	82.1	98.6	1.24	1.14	1.42	-1.3	-6.7	3.0
818-2A	2816	66.5	55.5	78.2	1.29	1.22	1.38	3.4	0.1	6.5
818-2B	2816	23.9	15.8	32.9	1.24	1.11	1.34	0.8	-2.8	4.5
819-2A	2816	93.7	86.1	99.1	1.31	1.11	1.56	-0.2	-8.5	5.5
820-2A	2816	91.7	84.6	98.0	1.64	1.32	1.97	1.9	-3.5	7.3
821-2A	2816	94.8	83.1	98.9	1.35	1.06	2.28	-2.6	-8.3	6.4

APPENDIX E

TEST RESULTS SUMMARY TABLES FOR THE VENTURI/SPRAY TOWER SYSTEM

Table E-1

SUMMARY OF FORCED-OXIDATION LIMESTONE TESTS ON THE TWO-LOOP VENTURI/SPRAY TOWER SYSTEM

Run Number	801-1A	802-1A	803-1A	804-1A
Start-of-Run Date	1/4/77	1/24/77	2/ 4/77	2/10/77
End-of-Run Date	1/15/77	2/ 4/77	2/10/77	2/18/77
On Stream Hours	263	250	138	151
Fly Ash	Yes	Yes	Yes	Yes
MgO Addition	No	No	No	No
Gas Rate, acfm at 300°F	25,000	25,000	25,000	25,000
Spray Tower Gas Vel., ft/sec @ 125°F	6.7	6.7	6.7	6.7
Venturi Liquor Rate, gpm	400	400	600	600
Venturi L/G, gal/Mcf	20	20	30	30
Spray Tower Liquor Rate, gpm	1300	1400	1400	1400
Spray Tower L/G, gal/Mcf	65	70	70	70
Venturi Percent Solids Recirculated	12.3 - 16.8	12.4 - 15.9	13.8 - 16.8	13.2 - 16.6
Spray Tower Percent Solids Recirculated	4.9 - 6.7	4.6 - 7.6	4.5 - 6.1	5.9 - 8.9
Venturi Oxidation Tank Residence Time, min.	17	17	11.3	11.3
Venturi Desupersaturation Tank Residence Time, min.	7	7	4.7	4.7
Spray Tower Effluent Residence Time, min.	19.4	18	18	18
Solids Disposal System	Clarifier & Filter	Clarifier & Filter	Clarifier & Filter	Clarifier & Filter
Stoichiometric Ratio in Venturi Inlet Slurry, moles Ca/mole SO_2	1.02 - 1.17	1.03 - 1.37	1.07 - 1.23	1.05 - 1.22
Stoichiometric Ratio in Spray Tower Inlet Slurry, moles Ca/mole SO_2	1.12 - 1.28	1.22 - 1.52	1.33 - 1.60	1.25 - 1.65
Overall Avg. % Limestone Utilization, 100 x moles SO_2 abs./mole Ca added	91	83	87	88
Inlet SO_2 Concentration, ppm	2900 - 3900	3000 - 4000	2900 - 3400	2600 - 3700
Inlet O_2 Concentration, vol. %	4.5 - 7.8	4.5 - 7.8	5.8 - 7.2	6.1 - 8.1
Overall Percent SO_2 Removal	58 - 66	52 - 67	62 - 72	66-76
Average SO_2 Make-per-pass, m-mole/l	7	6.5	5.6	6
Venturi Inlet pH Range	4.3 - 4.9	4.7 - 5.3	4.5 - 5.1	4.9 - 5.2
Venturi Outlet pH Range	3.7 - 4.1	4.15 - 4.55	4.1 - 4.5	4.2 - 4.7
Spray Tower Inlet pH Range	5.5 - 5.9	5.3 - 5.75	5.5 - 5.8	5.65 - 5.95
Spray Tower Outlet pH Range	--	--	--	--
Percent Sulfite Oxidized in Venturi Inlet Slurry	88 - 98	91 - 99	94 - 98	96 - 99
Percent Sulfite Oxidized in Spray Tower Inlet Slurry	7 - 19	10 - 22	10 - 22	10 - 20
Air Flow Rate to Oxidizer, scfm	400	400	400	400
Avg. Air Stoichiometric Ratio lb-atoms oxygen/lb-mole SO_2 absorbed	4.7	4.7	4.7	4.6
Solids in Sludge Discharged, %	76 - 86	82 - 90	77 - 85	79 - 91
Calculated Avg. % Gypsum Saturation in Venturi Inlet Liquor @ 50°C	100	110	105	105
Calculated Avg. % Gypsum Saturation in Spray Tower Inlet Liquor @ 50°C	75	110	120	105
Total Dissolved Solids in Venturi Inlet Liquor, ppm	5600 - 7300	7600 - 9400	9200 - 10,600	10,100 - 11,600
Total Dissolved Solids in Spray Tower Inlet Liquor, ppm	3200 - 5600	5300 - 7500	7000 - 8000	7200 - 8500
Total ΔP Range, Excluding Mist Elimination System, in. H_2O	10.6 - 11.6	10.4 - 11.2	10.6 - 11.3	9.9 - 11.2
Venturi ΔP, in. H_2O	9	9	9	9
Mist Elimination System ΔP Range, in. H_2O	0.14 - 0.22	0.20 - 0.34	0.20 - 0.30	0.30 - 0.37 (first 96 hrs) 0.19 - 0.25 to end of run
Mist Elimination System Configuration	3-pass, open-vane, 316L SS chevron mist eliminator.	3-pass, open-vane, 316L SS chevron mist eliminator.	3-pass, open-vane, 316L SS chevron mist eliminator.	3-pass, open-vane, 316L SS chevron mist eliminator.
Mist Eliminator Wash Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 minutes (at 0.53 gpm/sq. ft.) with 7 minutes off between nozzles. Bottom washed intermittently with makeup water at 1.5 gpm/sq. ft. for 4 minutes every hour.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 minutes (at 0.53 gpm/sq. ft.) with 7 minutes off between nozzles. Bottom washed intermittently with makeup water at 1.5 gpm/sq. ft. for 4 minutes every hour.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 minutes (at 0.53 gpm/sq. ft.) with 7 minutes off between nozzles. Bottom washed intermittently with makeup water at 1.5 gpm/sq. ft. for 4 minutes every hour.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 minutes (at 0.53 gpm/sq. ft.) with 7 minutes off between nozzles. Bottom washed intermittently with makeup water at 1.5 gpm/sq. ft. for 4 minutes every hour.

Table E-1 (continued)

SUMMARY OF FORCED-OXIDATION LIMESTONE TESTS ON THE TWO-LOOP VENTURI/SPRAY TOWER SYSTEM

Run Number	801-1A	802-1A	803-1A	804-1A
Oxidizer Design	Octagonal sparger ring with 130 1/8 inch diameter holes on bottom side. Sparger ring made of 3 inch 316L S.S. pipe with 21.5 inch sides and located 6 inches from tank bottom. Oxidation tank diameter is 8 ft.	Octagonal sparger ring with 130 1/8 inch diameter holes on bottom side. Sparger ring made of 3 inch 316L S.S. pipe with 21.5 inch sides and located 6 inches from tank bottom. Oxidation tank diameter is 8 ft.	Octagonal sparger ring with 130 1/8 inch diameter holes on bottom side. Sparger ring made of 3 inch 316L S.S. pipe with 21.5 inch sides and located 6 inches from tank bottom. Oxidation tank diameter is 8 ft.	Octagonal sparger ring with 130 1/8 inch diameter holes on bottom side. Sparger ring made of 3 inch 316L S.S. pipe with 21.5 inch sides and located 6 inches from tank bottom. Oxidation tank diameter is 8 ft.
Absorbent	Limestone slurried to 60 wt % with clarified liquor and added to spray tower EHT.	Limestone slurried to 60 wt % with clarified liquor and added to spray tower EHT.	Limestone slurried to 60 wt % with clarified liquor and added to spray tower EHT.	Limestone slurried to 60 wt % with clarified liquor and added to spray tower EHT.
Scrubber Internals	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.
System Changes before Start of Run	System modified for two series scrubber operation with independent slurry recirculation loop for venturi scrubber and spray tower. Mist eliminator was not cleaned prior to the run.	No changes. No cleaning.	Mist eliminator cleaned. No other changes.	No cleaning prior to run, but mist eliminator cleaned after 94 hours of operation when it was 10% restricted. Clarified liquor return line modified to return liquor to spray tower EHT and/or oxidation tank.
Method of Control	Venturi inlet pH controlled at 4.5 ± 0.2. Venturi recirculated slurry solids controlled at 15 ± 1%. Clarified liquor returned to spray tower EHT.	Venturi inlet pH controlled at 5.0 ± 0.2. Venturi recirculated slurry solids controlled at 15 ± 1%. Clarified liquor returned to spray tower EHT.	Venturi inlet pH controlled at 5.0 ± 0.2. Venturi recirculated slurry solids controlled at 15 ± 1%. Clarified liquor returned to spray tower EHT.	Venturi inlet pH controlled at 5.0 ± 0.2. Venturi recirculated slurry solids controlled at 15 ± 1%, and spray tower solids at 8 ± 1%. Clarified liquor returned to both spray tower EHT & oxidation tank.
Run Philosophy	First two-stage oxidation test with limestone scrubbing. Test conditions chosen to achieve complete sulfite oxidation and satisfactory SO_2 removal.	To observe if a higher spray tower stoichiometry (higher controlled venturi inlet pH of 5.0) improves the overall SO_2 removal.	To improve the SO_2 removal by increasing the venturi slurry flow rate to 600 gpm (cf. 400 gpm for Run 802-1A). All other test conditions same as for Run 802-1A.	To observe the effect of a high percent solids in the spray tower loop (8% cf. 4.5 - 7.5% for Runs 801-, 802-, and 803-1A) on SO_2 removal. Direct comparison with Run 803-1A.
Results	Overall SO_2 removal averaged only 62% and limestone utilization 91%. Sulfite oxidation averaged 93%. Filter cake solids averaged 81 wt. %. The mist eliminator was 2% restricted at the end of the run.	The overall SO_2 removal averaged only 60% (cf. 62% for Run 801-1A) at an overall limestone utilization of 83% (cf. 91% for Run 801-1A). Sulfite oxidation averaged 95% and filter cake solids 86 wt. %. The mist eliminator was 10% restricted at the end of the run.	Overall SO_2 removal averaged 67% (cf. 60% for Run 802-1A) at an overall limestone utilization of 87% (cf. 83% for Run 802-1A). The inlet SO_2 concentration range was 2900-3400 ppm (cf. 3000-4000 ppm for Run 802-1A). The mist eliminator was 2% restricted at the end of the run.	Overall SO_2 removal averaged 71% (cf. 67% for Run 803-1A) at an overall limestone utilization of 88% (cf. 87% for Run 803-1A). The mist eliminator was 10% restricted after 94 hrs, cleaned to 0.5% restricted, and was 1.5% restricted at the end of the run after a further 58 op. hours.

Table E-1 (continued)

SUMMARY OF FORCED-OXIDATION LIMESTONE TESTS ON THE TWO-LOOP VENTURI/SPRAY TOWER SYSTEM

Run Number	805-1A	806-1A	806-1B	806-1C
Start-of-Run Date	2/18/77	2/23/77	2/25/77	2/27/77
End-of-Run Date	2/23/77	2/25/77	2/27/77	3/ 1/77
On Stream Hours	112	45	45	54
Fly Ash	Yes	Yes	Yes	Yes
MgO Addition	No	No	No	No
Gas Rate, acfm at 300°F	25,000	25,000	25,000	25,000
Spray Tower Gas Vel., ft/sec @ 125°F	6.7	6.7	6.7	6.7
Venturi Liquor Rate, gpm	600	600	600	600
Venturi L/G, gal/Mcf	30	30	30	30
Spray Tower Liquor Rate, gpm	1400	1400	1400	1400
Spray Tower L/G, gal/Mcf	70	70	70	70
Venturi Percent Solids Recirculated	13 - 15.8	13.2 - 15.8	13.6 - 16.4	14.0 - 15.4
Spray Tower Percent Solids Recirculated	13.6 - 17.6	14.1 - 16.0	13.9 - 15.1	13.3 - 15.0
Venturi Oxidation Tank Residence Time, min.	11.3	11.3	11.3	11.3
Venturi Desupersaturation Tank Residence Time, min.	4.7	4.7	4.7	4.7
Spray Tower Effluent Residence Time, min.	18	18	18	18
Solids Disposal System	Clarifier & Filter	Clarifier & Filter	Clarifier & Filter	Clarifier & Filter
Stoichiometric Ratio in Venturi Inlet Slurry, moles Ca/mole SO_2	1.05 - 1.25	1.02 - 1.08	1.02 - 1.08	1.01 - 1.07
Stoichiometric Ratio in Spray Tower Inlet Slurry, moles Ca/mole SO_2	1.33 - 1.73	1.2 - 1.4	1.2 - 1.25	1.15 - 1.35
Overall Avg. % Limestone Utilization, 100x moles SO_2 abs./mole Ca added	87	95	95	96
Inlet SO_2 Concentration, ppm	3000 - 3900	3000 - 3800	2500 - 3200	3000 - 3500
Inlet O_2 Concentration, vol. %	5.0 - 7.7	5.0 - 5.6	4.2 - 6.6	4.8 - 6.8
Overall Percent SO_2 Removal	74 - 82	70 - 76	71 - 77	70 - 76
Avg. SO_2 Make-per-pass, m-mole/l	7	6.5	5.5	6.5
Venturi Inlet pH Range	4.7 - 5.2	4.35 - 4.65	4.45 - 4.6	4.4 - 4.6
Venturi Outlet pH Range	4.1 - 4.6	3.5 - 3.8	3.6 - 3.9	3.5 - 3.95
Spray Tower Inlet pH Range	6.05 - 6.25	6.05 - 6.25	5.9 - 6.25	5.85 - 6.15
Spray Tower Outlet pH Range	--	--	--	--
Percent Sulfite Oxidized in Venturi Inlet Slurry	97 - 99	97 - 100	96 - 99	94 - 99.5
Percent Sulfite Oxidized in Spray Tower Inlet Slurry	5 - 16	0 - 20	10 - 20	10 - 24
Air Flow Rate to Oxidizer, acfm	400	250	150	100
Avg. Air Stoichiometric Ratio, lb-atoms oxygen/lb-mole SO_2 absorbed	3.7	2.5	1.7	1.0
Solids in Sludge Discharged, %	75 - 87	78 - 90	76 - 87	74 - 84
Calculated Avg. % Gypsum Saturation in Venturi Inlet Liquor @ 50°C	95	95	95	100
Calculated Avg. % Gypsum Saturation in Spray Tower Inlet Liquor @ 50°C	25	20	55	50
Total Dissolved Solids in Venturi Inlet Liquor, ppm	11,600 - 12,100	11,200 - 12,000	11,500 - 12,900	10,900 - 11,700
Total Dissolved Solids in Spray Tower Inlet Liquor, ppm	2900 - 4400	2600 - 3000	3300 - 4100	2500 - 4000
Total ΔP Range, Excluding Mist Elimination System, in. H_2O	10.1 - 10.7	10.7 - 11.9	11.5 - 12.1	10.8 - 12.7
Venturi ΔP, in. H_2O	9	9	9	9
Mist Elimination System ΔP Range, in. H_2O	0.23 - 1.22	0.23 - 0.30	0.30 - 0.37	0.37 - 0.41
Mist Elimination System Configuration	3-pass, open-vane, 316L SS chevron mist eliminator.	3-pass, open-vane, 316L SS chevron mist eliminator.	3-pass, open-vane, 316L SS chevron mist eliminator.	3-pass, open-vane, 316L SS chevron mist eliminator.
Mist Eliminator Washing Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 minutes (at 0.53 gpm/sq. ft.) with 7 minutes off between nozzles. Bottom washed intermittently with makeup water at 1.5 gpm/sq. ft. for 4 minutes every hour.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 minutes (at 0.53 gpm/sq. ft.) with 7 minutes off between nozzles. Bottom washed intermittently with makeup water at 1.5 gpm/sq. ft. for 4 minutes every hour.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 minutes (at 0.53 gpm/sq. ft.) with 7 minutes off between nozzles. Bottom washed intermittently with makeup water at 1.5 gpm/sq. ft. for 4 minutes every hour.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 minutes (at 0.53 gpm/sq. ft.) with 7 minutes off between nozzles. Bottom washed intermittently with makeup water at 1.5 gpm/sq. ft. for 4 minutes every hour.

Table E-1 (continued)

SUMMARY OF FORCED-OXIDATION LIMESTONE TESTS ON THE TWO-LOOP VENTURI/SPRAY TOWER SYSTEM

Run Number	805-1A	806-1A	806-1B	806-1C
Oxidizer Design	Octagonal sparger ring with 130 1/8 inch diameter holes on bottom side. Sparger ring made of 3 inch 316L SS pipe with 21.5 inch sides and located 6 inches from the tank bottom. Oxidation tank diameter is 8 ft.	Octagonal sparger ring with 130 1/8 inch diameter holes on bottom side. Sparger ring made of 3 inch 316L SS pipe with 21.5 inch sides and located 6 inches from the tank bottom. Oxidation tank diameter is 8 ft.	Octagonal sparger ring with 130 1/8 inch diameter holes on bottom side. Sparger ring made of 3 inch 316L SS pipe with 21.5 inch sides and located 6 inches from the tank bottom. Oxidation tank diameter is 8 ft.	Octagonal sparger ring with 130 1/8 inch diameter holes on bottom side. Sparger ring made of 3 inch 316L SS pipe with 21.5 inch sides and located 6 inches from the tank bottom. Oxidation tank diameter is 8 ft.
Absorbent	Limestone slurried to 60 wt % with clarified liquor and added to spray tower EHT.	Limestone slurried to 60 wt % with clarified liquor and added to spray tower EHT.	Limestone slurried to 60 wt % with clarified liquor and added to spray tower EHT.	Limestone slurried to 60 wt % with clarified liquor and added to spray tower EHT.
Scrubber Internals	Four spray headers. Top 3 headers sprayed downwards. Bottom header sprayed upwards. 7 nozzles/header.	Four spray headers. Top 3 headers sprayed downwards. Bottom header sprayed upwards. 7 nozzles/header.	Four spray headers. Top 3 headers sprayed downwards. Bottom header sprayed upwards. 7 nozzles/header.	Four spray headers. Top 3 headers sprayed downwards. Bottom header sprayed upwards. 7 nozzles/header.
System Changes before Start of Run	No changes. No cleaning.	Mist eliminator cleaned. No other changes.	(No shutdown.)	(No shutdown.)
Method of Control	Venturi inlet pH controlled at 5.0 ± 0.2. Venturi recirculated slurry solids controlled at 15 ± 1%. All clarified liquor returned to oxidation tank to maximize percent solids in spray tower loop.	Venturi inlet pH controlled at 4.5 ± 0.2. Venturi recirculated slurry solids controlled at 15 ± 1%. All clarified liquor returned to oxidation tank.	Venturi inlet pH controlled at 4.5 ± 0.2. Venturi recirculated slurry solids controlled at 15 ± 1%. All clarified liquor returned to oxidation tank.	Venturi inlet pH controlled at 4.5 ± 0.2. Venturi recirculated slurry solids controlled at 15 ± 1%. All clarified liquor returned to oxidation tank.
Run Philosophy	To observe the effect of maximum percent solids in spray tower loop on SO_2 removal. Same test conditions as Run 804-1A except all clarified liquor returned to venturi loop.	To observe the effect of a lower air flow to sparger (250 acfm cf. 400 acfm for Run 805-1A) on sulfite oxidation at 4.5 venturi inlet pH. All other test conditions same as for Run 805-1A.	To observe the effect of a still lower air flow to sparger (150 acfm cf. 250 acfm for Run 806-1A) on sulfite oxidation. All other test conditions same as for Run 806-1A.	To observe the effect of a still lower air flow to sparger (100 acfm cf. 150 acfm for Run 806-1B) on sulfite oxidation. All other test conditions same as for Run 806-1B.
Results	The overall SO_2 removal averaged 78% and the limestone utilization 87% (cf. 71% removal and 88% utilization for Run 804-1A). Recirculated solids in spray tower loop averaged 15.6% (cf. 7.4% for Run 804-1A). The mist eliminator was 40% restricted at the end of the run.	Sulfite oxidation in the venturi inlet slurry averaged 99% (cf. 98% for Run 805-1A). The scrubber was not shut down at the end of the run.	Sulfite oxidation in the venturi inlet slurry averaged 98% (cf. 99% for Run 806-1A). The scrubber was not shut down at the end of the run.	Sulfite oxidation in the venturi inlet slurry average 97% (cf. 98% for Run 806-1B). The scrubber was not shut down at the end of the run.

Table E-1 (continued)

SUMMARY OF FORCED-OXIDATION LIMESTONE TESTS ON THE TWO-LOOP VENTURI/SPRAY TOWER SYSTEM

Run Number	806-1D	807-1A	808-1A	809-1A
Start-of-Run Date	3/1/77	3/3/77	3/6/77	8/12/77
End-of-Run Date	3/3/77	3/6/77	3/9/77	8/18/77
On Stream Hours	41	66	65	137
Fly Ash	Yes	Yes	Yes	No
MgO Addition	No	No	No	No
Gas Rate, acfm at 300°F	25,000	25,000	25,000	25,000
Spray Tower Gas Vel., ft/sec @ 125°F	6.7	6.7	6.7	6.7
Venturi Liquor Rate, gpm	600	600	600	600
Venturi L/G, gal/Mcf	30	30	30	30
Spray Tower Liquor Rate, gpm	1400	1400	1400	1400
Spray Tower L/G, gal/Mcf	70	70	70	70
Venturi Percent Solids Recirculated	13.6 - 15.2	13.4 - 15.8	14.3 - 15.9	13.5 - 16.1
Spray Tower Percent Solids Recirculated	15.4 - 16.3	16 - 17.1	14.8 - 16.2	7.3 - 8.4
Venturi Oxidation Tank Residence Time, min.	11.3	11.3	11.3	11.3
Venturi Desupersaturation Tank Residence Time, min.	4.7	4.7	4.7	4.7
Spray Tower Effluent Residence Time, min.	18	18	18	13.4
Solids Disposal System	Clarifier & Filter	Clarifier & Filter	Clarifier & Filter	Clar. & Fil./Lamella Settler
Stoichiometric Ratio in Venturi Inlet Slurry, moles Ca/mole SO_2	1.05 - 1.14	1.06 - 1.14	1.01 - 1.04	1.00 - 1.05
Stoichiometric Ratio in Spray Tower Inlet Slurry, moles Ca/mole SO_2	1.3 - 1.4	1.27 - 1.40	1.10 - 1.30	1.17 - 1.42
Overall Avg. % Limestone Utilization, 100x moles SO_2 abs./mole Ca added	91	91	98	98
Inlet SO_2 Concentration, ppm	2800 - 3350	2900 - 3750	2650 - 3100	2200 - 2700
Inlet O_2 Concentration, vol. %	6.0 - 6.4	4.2 - 8.3	5.5 - 7.5	8.5 - 10.4
Overall Percent SO_2 Removal	77 - 83	74 - 83	70 - 81	77 - 86
Avg. SO_2 Make-Per-Pass, m-mole/l	6.5	7.0	5.5	5.3
Venturi Inlet pH Range	4.45 - 4.6	4.35 - 4.6	4.3 - 4.65	4.4 - 4.7
Venturi Outlet pH Range	4.2 - 4.4	4.25 - 4.35	3.3 - 3.9	2.9 - 3.8
Spray Tower Inlet pH Range	6.1 - 6.25	6.2 - 6.35	6.1 - 6.35	5.5 - 5.85
Spray Tower Outlet pH Range	--	--	--	--
Percent Sulfite Oxidized in Venturi Inlet Slurry	50 - 84	7 - 29	94 - 99	96 - 99
Percent Sulfite Oxidized in Spray Tower Inlet Slurry	8 - 22	3 - 10	6 - 25	5 - 36
Air Flow Rate to Oxidizer, acfm	50	0	150	150
Avg. Air Stoichiometric Ratio, lb-atoms oxygen/lb-mole SO_2 absorbed	0.50	0	1.70	1.85
Solids in Sludge Discharged, %	74 - 83	66 - 81	78 - 86	72 - 88/27 - 43
Calculated Avg. % Gypsum Saturation in Venturi Inlet Liquor @ 50°C	105	135	100	95
Calculated Avg. % Gypsum Saturation in Spray Tower Inlet Liquor @ 50°C	15	8	23	105
Total Dissolved Solids in Venturi Inlet Liquor, ppm	10,200 - 12,200	10,400 - 11,800	9400 - 10,400	11,800 - 14,800
Total Dissolved Solids in Spray Tower Inlet Liquor, ppm	2400 - 2800	1840 - 2140	1690 - 1890	7800 - 8700
Total ΔP Range, Excluding Mist Elimination System, in. H_2O	10.4 - 11.0	10.4 - 11.0	10.5 - 11.1	11.6 - 12.0
Venturi ΔP, in. H_2O	9	9	9	9
Mist Elimination System ΔP Range, in. H_2O	0.64 - 0.78	0.26 - 0.40	0.45 - 0.70	0.29 - 0.35
Mist Elimination System Configuration	3-pass, open-vane, 316L SS chevron mist eliminator.	3-pass, open-vane, 316L SS chevron mist eliminator.	3-pass, open-vane, 316L SS chevron mist eliminator.	3-pass, open-vane, 316L SS chevron mist eliminator.
Mist Eliminator Washing Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 minutes (at 0.53 gpm/sq. ft.) with 7 minutes off between nozzles. Bottom washed intermittently with makeup water at 1.5 gpm/sq. ft. for 4 minutes every hour.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 minutes (at 0.53 gpm/sq. ft.) with 7 minutes off between nozzles. Bottom washed intermittently with makeup water at 1.5 gpm/sq. ft. for 4 minutes every hour.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 minutes (at 0.53 gpm/sq. ft.) with 7 minutes off between nozzles. Bottom washed intermittently with makeup water at 1.5 gpm/sq. ft. for 4 minutes every hour.	Top washed sequentially with makeup water. Each nozzle (6 total) on 4 min (at 0.53 gpm/sq. ft.) with 76 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (about 5 gpm makeup water plus 10 gpm clarified liquor) through 4 nozzles at 0.3 gpm/sq. ft.

Table E-1 (continued)

SUMMARY OF FORCED-OXIDATION LIMESTONE TESTS ON THE TWO-LOOP VENTURI/SPRAY TOWER SYSTEM

Run Number	806-1D	807-1A	808-1A	809-1A
Oxidizer Design	Octagonal sparger ring with 130 1/8 inch diameter holes on bottom side. Sparger ring made of 3 inch 316L SS pipe with 21.5 inch sides and located 6 inches from the tank bottom. Oxidation tank diameter is 8 ft.	Octagonal sparger ring with 130 1/8 inch diameter holes on bottom side. Sparger ring made of 3 inch 316L SS pipe with 21.5 inch sides and located 6 inches from the tank bottom. Oxidation tank diameter is 8 ft. (Air flow turned off.)	Octagonal sparger ring with 130 1/8 inch diameter holes on bottom side. Sparger ring made of 3 inch 316L SS pipe with 21.5 inch sides and located 6 inches from the tank bottom. Oxidation tank diameter is 8 ft.	Octagonal sparger ring with 40 1/4 inch diameter holes on bottom side. Sparger ring made of 3 inch 316L SS pipe with 21.5 inch sides and located 6 inches from tank bottom. Oxidation tank diameter is 8 ft. Tank slurry level was 18 ft.
Absorbent	Limestone slurried to 60 wt % with clarified liquor and added to spray tower EHT.	Limestone slurried to 60 wt% with clarified liquor and added to spray tower EHT.	Limestone slurried to 60 wt% with clarified liquor and added to spray tower EHT.	Limestone slurried to 60 wt% with makeup water and added to spray tower EHT.
Scrubber Internals	Four spray headers. Top 3 headers sprayed downwards. Bottom header sprayed upwards. 7 nozzles/header.	Four spray headers. Top 3 headers sprayed downwards. Bottom header sprayed upwards. 7 nozzles/header.	Four spray headers. Top 3 headers sprayed downwards. Bottom header sprayed upwards. 7 nozzles/header.	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.
System Changes before Start of Run	(No shutdown.)	The venturi return slurry entrance point at the oxidation tank was changed from a top-tank entry to a bottom tank entry to create an upward slurry flow in order to prevent solids from settling out in the tank. The mist eliminator was cleaned.	(No shutdown.)	Cleaned reheater outlet duct and outside of trap-out tray. No other changes.
Method of Control	Venturi inlet pH controlled at 4.5 ± 0.2. Venturi recirculated slurry solids controlled at 15 ± 1%. All clarified liquor returned to oxidation tank.	Venturi inlet pH controlled at 4.5 ± 0.2. Venturi recirculated slurry solids controlled at 15 ± 1%. All clarified liquor returned to oxidation tank.	Venturi inlet pH controlled at 4.5 ± 0.2. Venturi recirculated slurry solids controlled at 15 ± 1%. All clarified liquor returned to oxidation tank.	Venturi inlet pH controlled at 4.5 ± 0.2 by limestone addition to spray tower EHT. Venturi recirculated slurry solids controlled at 15 ± 1%. All clarified liquor returned to spray tower EHT.
Run Philosophy	To observe the effect of a still lower air flow to sparger (52 scfm cf. 100 scfm for Run 806-1C) on sulfite oxidation. All other test conditions same as for Run 806-1C.	To determine the base case sulfite oxidation level with no air sparging.	To determine whether the change in the slurry flow pattern (to an upward slurry flow within the oxidation tank) had an effect on the sulfite oxidation, in comparison with Run 806-1B.	First two-stage forced oxidation run with limestone scrubbing and fly ash-free flue gas. Run conditions chosen to achieve complete sulfite oxidation and satisfactory SO_2 removal.
Results	Sulfite oxidation in the venturi inlet slurry averaged 67% (cf. 97% for Run 806-1C) but ranged widely from 50 to 84%. The mist eliminator was 50% restricted at the end of run and heavy mud was built up on the trap-out tray rim constricting gas flow.	With no air sparging, the sulfite oxidation in the venturi inlet slurry dropped to 18% with 91% limestone utilization and 135% venturi inlet liquor gypsum saturation. The scrubber was not shut down at the end of the run.	Sulfite oxidation averaged 97% vs. 98% for Run 806-1B. The revised flow pattern in the oxidation tank did not appear to affect the level of sulfite oxidation. The mist eliminator was about 35% restricted at the end of the run.	Sulfite oxidation averaged 98% and overall SO_2 removal averaged 82%. Limestone utilization averaged 98%. The mist eliminator was 0.5% restricted.

Table E-1 (continued)

SUMMARY OF FORCED-OXIDATION LIMESTONE TESTS ON THE TWO-LOOP VENTURI/SPRAY TOWER SYSTEM

Run Number	810-1A	811-1A	812-1A	814-1A
Start-of-Run Date	8/16/77	8/23/77	9/02/77	9/08/77
End-of-Run Date	8/23/77	9/ 2/77	9/08/77	9/15/77
On Stream Hours	162	184	141	156
Fly Ash	No	No	No	No
MgO Addition	No	No	No	No
Gas Rate, acfm @ 300°F	25,000	25,000	25,000	25,000
Spray Tower Gas Vel., ft/sec @ 125°F	6.7	6.7	6.7	6.7
Venturi Liquor Rate, gpm	600	600	600	600
Venturi L/G, gal/Mcf	30	30	30	30
Spray Tower Liquor Rate, gpm	1400	1400	1400	1400
Spray Tower L/G, gal/Mcf	70	70	70	70
Venturi Percent Solids Recirculated	12.2 - 17.0	12.6 - 16.0	14.6 - 16.9	13.7 - 15.9
Spray Tower Percent Solids Recirculated	6.5 - 9.6	7.0 - 9.0	6.0 - 7.9	7.5 - 9.2
Venturi Oxidation Tank Residence Time, min.	11.3	11.3	11.3	8.6
Venturi Desupersaturation Tank Residence Time, min	4.7	4.7	--	4.7
Spray Tower Effluent Residence Time, min.	13.4	13.4	13.4	13.4
Solids Disposal System	Clarifier	Clarifier	Clarifier & Filter	Clarifier & Filter
Stoichiometric Ratio in Venturi Inlet Slurry, moles Ca/mole SO_2	1.01 - 1.07	1.01 - 1.07	1.02 - 1.46	1.06 - 1.36
Stoichiometric Ratio in Spray Tower Inlet Slurry, moles Ca/mole SO_2	1.14 - 1.56	1.25 - 1.55	1.37 - 2.49	1.40 - 2.06
Overall Avg. % Limestone Utilization, 100 x moles SO_2 abs./mole Ca added	96	96	81	83
Inlet O_2 Concentration, vol. %	7.0 - 8.8	7.5 - 9.1	6.7 - 8.2	6.0 - 8.5
Inlet SO_2 Concentration, ppm	2200 - 3200	2200 - 3000	1950 - 2750	2100 - 2600
Overall Percent SO_2 Removal	76 - 89	80 - 90	90 - 96	86 - 96
Average SO_2 Make-Per-Pass, m-mole/l	5.6	5.7	5.76	5.83
Venturi Inlet pH Range	4.8 - 5.3	5.3 - 5.7	5.2 - 6.0	5.3 - 5.6
Venturi Outlet pH Range	3.7 - 4.9	4.4 - 4.8	4.4 - 5.2	4.2 - 4.8
Spray Tower Inlet pH Range	5.65 - 5.96	5.8 - 6.0	5.8 - 6.1	5.8 - 6.7
Spray Tower Outlet pH Range	--	--	--	--
Percent Sulfite Oxidized in Venturi Inlet Slurry	96 - 99	94 - 100	95 - 99	96 - 100
Percent Sulfite Oxidized in Spray Tower Inlet Slurry	14 - 29	26 - 34	19 - 31	13 - 41
Air Flow Rate to Oxidizer, scfm	150	150	150	150
Avg. Air Stoichiometric Ratio, lb-atoms oxygen/lb-mole SO_2 absorbed	1.65	1.65	1.70	1.64
Solids in Sludge Discharged, %	37 - 55	38 - 52	80 - 92	84 - 92
Calculated Avg. % Gypsum Saturation in Venturi Inlet Liquor @ 50°C	95	104	106	106
Calculated Avg. % Gypsum Saturation in Spray Tower Inlet Liquor @ 50°F	105	109	100	100
Total Dissolved Solids in Venturi Inlet Liquor, ppm	6800 - 11,000	8500 - 9300	9200 - 10,200	10,100 - 10,600
Total Dissolved Solids in Spray Tower Inlet Liquor, ppm	6200 - 8100	5900 - 7000	6700 - 8600	7500 - 8100
Total ΔP Range, Excluding Mist Elimination System, in. H_2O	11.5 - 11.9	11.3 - 11.9	11.1 - 12.7	11.4 - 12.5
Venturi ΔP (nominal), in. H_2O	9	9	9	9
Mist Elimination System ΔP Range, in. H_2O	0.29 - 0.32	0.30 - 0.36	0.31 - 0.36	0.32 - 0.38
Mist Elimination System Configuration	3-pass, open-vane, 316L SS chevron mist eliminator.	3-pass, open-vane, 316L SS chevron mist eliminator.	3-pass, open-vane, 316L SS chevron mist eliminator.	3-pass, open-vane, 316L SS chevron mist eliminator.
Mist Eliminator Wash Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on 4 min. (at 0.53 gpm/sq. ft.) with 76 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (about 5 gpm makeup water plus 10 gpm clarified liquor) through 4 nozzles at 0.3 gpm/sq. ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on 4 min. (at 0.53 gpm/sq. ft.) with 76 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (about 5 gpm makeup water plus 10 gpm clarified liquor) through 4 nozzles at 0.3 gpm/sq. ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on 4 min. (at 0.53 gpm/sq. ft.) with 76 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water at about 5 gpm plus about 10 gpm clarified liquor) through 4 nozzles at 0.3 gpm/sq. ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on 4 min. (at 0.53 gpm/sq. ft.) with 76 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water at about 5 gpm plus about 10 gpm clarified liquor) through 4 nozzles at 0.3 gpm/sq. ft.

Note: Run 813-1A aborted.

Table E-1 (continued)

SUMMARY OF FORCED-OXIDATION LIMESTONE TESTS ON THE TWO-LOOP VENTURI/SPRAY TOWER SYSTEM

Run Number	810-1A	811-1A	812-1A	814-1A
Oxidizer Design	Octagonal sparger ring with 40 1/4 inch diameter holes on bottom side. Sparger ring made of 3 inch 316L SS pipe with 21.5 inch sides and located 6 inches from tank bottom. Oxidation tank diameter is 8 ft. Tank slurry level was 18 ft.	Octagonal sparger ring with 40 1/4 inch diameter holes on bottom side. Sparger ring made of 3 inch 316L SS pipe with 21.5 inch sides and located 6 inches from tank bottom. Oxidation tank diameter is 8 ft. Tank slurry level was 18 ft.	Octagonal sparger ring with 40 1/4 inch diameter holes on bottom side. Sparger ring made of 3 inch 316L SS pipe with 21.5 inch sides and located 6 inches from tank bottom. Oxidation tank diameter is 8 ft. Tank slurry level was 18 ft.	Octagonal sparger ring with 40 1/4 inch diameter holes on bottom side. Sparger ring made of 3 inch 316L SS pipe with 21.5 inch sides and located 6 inches from tank bottom. Oxidation tank diameter is 8 ft. Tank slurry level was 14 ft.
Absorbent	Limestone slurried to 60 wt.% with makeup water and added to spray tower EHT.	Limestone slurried to 60 wt.% with makeup water and added to spray tower EHT.	Limestone slurried to 60 wt% with makeup water and added to spray tower hold tank.	Limestone slurried to 60 wt% with makeup water and added to spray tower hold tank.
Scrubber Internals	Four spray headers. Top 3 headers sprayed downwards. Bottom header sprayed upwards. 7 nozzles/header.	Four spray headers. Top 3 headers sprayed downwards. Bottom header sprayed upwards. 7 nozzles/header.	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.
System Changes Before Start of Run	No changes. No cleaning.	Cleaned trap-out tray. No other changes.	No cleaning. Desupersaturation tank was excluded from venturi recirculated slurry loop. Venturi slurry recirculation pump took suction directly from oxidation tank.	Oxidation tank overflow nozzle lowered from 18 ft to 14 ft level. Inspected and cleaned air sparger. No other cleaning.
Method of Control	Venturi inlet pH controlled at 5.0 ± 2.0 by limestone addition to spray tower EHT. Venturi recirculated slurry solids controlled at 15 ± 1%. All clarified liquor returned to spray tower EHT.	Venturi inlet pH controlled at 5.5 ± 0.2 by limestone addition to spray tower EHT. Venturi recirculated slurry solids controlled at 15 ± 1%. All clarified liquor returned to spray tower EHT.	Venturi inlet pH controlled at 5.5 ± 0.2 by limestone addition to spray tower EHT. Venturi recirculated slurry solids controlled at 15 ± 1%. All clarified liquor returned to spray tower EHT.	Venturi inlet pH controlled at 5.5 ± 0.2 by limestone addition to spray tower EHT. Venturi recirculated slurry solids controlled at 15 ± 1%. All clarified liquor returned to spray tower EHT.
Run Philosophy	To test the effect of higher venturi inlet pH (5.0 compared to 4.5 for Run 809-1A) on sulfite oxidation and sludge characteristics.	To test the effect of higher venturi inlet pH (5.5 compared to 5.0 for Run 810-1A) on sulfite oxidation and sludge characteristics.	To observe if gypsum scaling would occur in the venturi system and if sulfite oxidation would be affected when operating without the desupersaturation tank.	To observe the effect of lower liquid depth (14 ft) in the air sparged tank on sulfite oxidation.
Results	Sulfite oxidation averaged 98%. Overall SO_2 removal averaged 83% and overall limestone utilization averaged 96%. The mist eliminator was 1% restricted.	Sulfite oxidation averaged 97%. Overall SO_2 removal averaged 85% and overall limestone utilization averaged 98%. The mist eliminator was 2% restricted.	Sulfite oxidation averaged 97% with 93% SO_2 removal and 81% limestone utilization. There was no evidence of scaling in the venturi scrubber. The mist eliminator was 2.5% restricted.	Average sulfite oxidation remained high at 98% with 91% SO_2 removal and 83% limestone utilization. The mist eliminator was 4% restricted.

Note: Run 813-1A aborted.

Table E-1 (continued)

SUMMARY OF FORCED-OXIDATION LIMESTONE TESTS ON THE TWO-LOOP VENTURI/SPRAY TOWER SYSTEM

Run Number	815-1A	816-1A	817-1A	818-1A
Start-of-Run Date	9/15/77	9/28/77	10/18/77	10/26/77
End-of-Run Date	9/28/77	10/4/77	10/26/77	11/1/77
On Stream Hours	306	142	188	141
Fly Ash	No	No	Yes	Yes
MgO Addition	No	No	No	No
Gas Rate, acfm @ 300°F	35,000	35,000	35,000	35,000
Spray Tower Gas Vel., ft/sec @ 125°F	9.4	9.4	9.4	9.4
Venturi Liquor Rate, gpm	600	600	600	600
Venturi L/G, gal/Mcf	21	21	21	21
Spray Tower Liquor Rate, gpm	1400	1400	1400	1600
Spray Tower L/G, gal/Mcf	50	50	50	57
Venturi Percent Solids Recirculated	13.0 - 16.3	13.4 - 16.2	15.1 - 16.4	14.8 - 15.8
Spray Tower Percent Solids Recirculated	7.0 - 9.8	6.5 - 8.8	8.0 - 9.7	8.7 - 10.4
Venturi Oxidation Tank Residence Time, min.	8.8	11.3	11.3	11.3
Venturi Desupersaturation Tank Residence Time, min.	4.7	4.7	4.7	4.7
Spray Tower Effluent Residence Time, min.	13.4	13.4	16.8	14.7
Solids Disposal System	Clarifier & Filter	Clarifier & Filter	Clarifier & Filter	Clarifier & Filter
Stoichiometric Ratio in Venturi Inlet Slurry, moles Ca/mole SO_2	1.07 - 1.90	1.06 - 1.36	1.19 - 1.33	1.11 - 1.35
Stoichiometric Ratio in Spray Tower Inlet Slurry, moles Ca/mole SO_2	1.25 - 2.72	1.52 - 1.85	1.46 - 1.74	1.42 - 1.95
Overall Avg. % Limestone Utilization, 100 x moles SO_2 abs. /mole Ca added	67	83	82	81
Inlet O_2 Concentration, vol. %	7.5 - 10.0	8.2 - 10.0	6.5 - 8.5	6.6 - 7.7
Inlet SO_2 Concentration, ppm	2000 - 3000	1900 - 2800	1900 - 3100	2000 - 3100
Overall Percent SO_2 Removal	78 - 94	82 - 90	77 - 89	82 - 90
Average SO_2 Make-Per-Pass, m-mole/l	7.92	7.44	7.6	7.8
Venturi Inlet pH Range	4.9 - 5.3	5.2 - 5.8	5.1 - 5.5	5.4 - 5.8
Venturi Outlet pH Range	4.1 - 5.2	4.2 - 4.8	4.5 - 4.9	4.4 - 4.8
Spray Tower Inlet pH Range	5.65 - 6.0	5.6 - 5.9	5.8 - 6.05	5.8 - 6.0
Spray Tower Outlet pH Range	5.4 - 5.9	5.3 - 5.8	5.5 - 6.0	5.6 - 6.0
Percent Sulfite Oxidized in Venturi Inlet Slurry	92 - 100	95 - 100	94 - 99	97 - 99
Percent Sulfite Oxidized in Spray Tower Inlet Slurry	15 - 37	18 - 36	13 - 28	12 - 26
Air Flow Rate to Oxidizer, scfm	210	210	210	210
Avg. Air Stoichiometric Ratio, lb-atoms oxygen/lb-mole SO_2 absorbed	1.70	1.80	1.78	1.70
Solids in Sludge Discharged, %	82 - 92	81 - 91	82 - 89	82 - 89
Calculated Avg. % Gypsum Saturation in Venturi Inlet Liquor @ 50°C	105	100	108	106
Calculated Avg. % Gypsum Saturation in Spray Tower Inlet Liquor @ 50°C	105	105	100	100
Total Dissolved Solids in Venturi Inlet Liquor, ppm	11,200 - 14,200	14,500 - 15,500	15,800 - 16,300	15,700 - 19,100
Total Dissolved Solids in Spray Tower Inlet Liquor, ppm	7900 - 10,700	9800 - 10,600	8,800 - 9,800	9,600 - 10,700
Total ΔP Range, Excluding Mist Elimination System, in. H_2O	14.8 - 17.3	15.6 - 16.0	14.6 - 16.0	14.1 - 15.9
Venturi ΔP (nominal), in. H_2O	9	9	9	9
Mist Elimination System ΔP Range, in. H_2O	0.58 - 0.76	0.88 - 0.70	0.55 - 0.66	0.57 - 0.68
Mist Elimination System Configuration	3-pass, open-vane, 316L SS chevron mist elimination.	3-pass, open-vane, 316L SS chevron mist elimination.	3-pass, open-vane, 316L SS chevron mist eliminator.	3-pass, open-vane, 316L SS chevron mist eliminator.
Mist Eliminator Wash Scheme	Top washed sequentially with makeup water. Each nozzle (5 total) on 4 min. (at 0.53 gpm/sq. ft.) with 76 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water at about 7 gpm plus about 13 gpm clarified liquor) through 5 nozzles at 0.4 gpm/sq. ft.	Top washed sequentially with makeup water. Each nozzle (5 total) on 4 min. (at 0.53 gpm/sq. ft.) with 76 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water at about 7 gpm plus about 13 gpm clarified liquor) through 5 nozzles at 0.4 gpm/sq. ft.	Top washed sequentially with makeup water. Each nozzle (5 total) on 4 min. (at 0.53 gpm/sq. ft.) with 76 min. off between nozzles. Bottom washed continuously using 6 nozzles with diluted clarified liquor (all available makeup water plus necessary clarified liquor) at 0.4 gpm/sq. ft.	Top washed sequentially with makeup water. Each nozzle (5 total) on 4 min. (at 0.53 gpm/sq. ft.) with 76 min. off between nozzles. Bottom washed continuously using 6 nozzles with diluted clarified liquor (all available makeup water plus necessary clarified liquor) at 0.4 gpm/sq. ft.

Table E-1 (continued)

SUMMARY OF FORCED-OXIDATION LIMESTONE TESTS ON THE TWO-LOOP VENTURI/SPRAY TOWER SYSTEM

Run Number	815-1A	816-1A	817-1A	818-1A
Oxidizer Design	Octagonal sparger ring with 40 1/4 inch diameter holes on bottom side. Sparger ring made of 3 inch 316L SS pipe with 21.5 inch sides and located 6 inches from tank bottom. Oxidation tank diameter is 8 ft. Tank slurry level was 14 ft.	Octagonal sparger ring with 40 1/4 inch diameter holes on bottom side. Sparger ring made of 3 inch 316L SS pipe with 21.5 inch sides and located 6 inches from tank bottom. Oxidation tank diameter is 8 ft. Tank slurry level was 18 ft.	A single 3 inch diameter 316L SS pipe which extends to the center of the oxidation tank and discharges air downward through an open elbow 3 inches from bottom of tank. Oxidation tank diameter is 8 ft. Tank slurry level was 18 ft.	A single 3 inch diameter 316L SS pipe which extends to the center of the oxidation tank and discharges downward through an open elbow 3 inches from bottom of tank. Oxidation tank diameter is 8 ft. Tank slurry level was 18 ft.
Absorbent	Limestone slurried to 60 wt% with makeup water and added to spray tower hold tank.	Limestone slurried to 60 wt% with makeup water and added to spray tower hold tank.	Limestone slurried to 60 wt% with makeup water and added to spray tower hold tank.	Limestone slurried to 60 wt% with makeup water and added to spray tower hold tank.
Scrubber Internals	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.
System Changes Before Start of Run	No changes. No cleaning.	Oxidation tank overflow nozzle raised from 14 ft to 18 ft level. No cleaning.	No changes. No cleaning.	No changes. No cleaning.
Method of Control	Venturi inlet pH controlled at 5.5 ± 0.2 by limestone addition to spray tower EHT. Venturi recirculated slurry solids controlled at 15 ± 1%. All clarified liquor returned to spray tower EHT.	Venturi inlet pH controlled at 5.5 ± 0.2 by limestone addition to spray tower EHT. Venturi recirculated slurry solids controlled at 15 ± 1%. All clarified liquor returned to spray tower EHT.	Venturi inlet pH controlled at 5.5 ± 0.2 by limestone addition to spray tower EHT. Venturi recirculated slurry solids controlled at 15 ± 1%. Clarified liquor in excess of mist eliminator wash returned to oxidation tank.	Venturi inlet pH controlled at 5.8 ± 0.2 by limestone addition to spray tower EHT. Venturi recirculated slurry solids controlled at 15 ± 1%. Clarified liquor in excess of mist eliminator wash returned to oxidation tank.
Run Philosophy	To observe whether complete sulfite oxidation and satisfactory SO_2 removal could be achieved at the full flue gas flow rate of 35,000 acfm and venturi inlet pH of 5.5.	To test whether the increased oxidation tank residence time, which improves limestone dissolution, would provide a better venturi inlet pH control.	To obtain reliable mist eliminator operation using the continuous bottom wash with diluted clarified liquor, and to observe the maximum SO_2 removal obtainable at the level of spray tower slurry solids obtained by returning excess mist elim. liquor to oxid. tank.	To observe whether the SO_2 removal could meet the emission standard (84% removal @ 2800 ppm) at 35,000 acfm gas rate and 1400 gpm spray tower liquor rate.
Results	Sulfite oxidation averaged 98% with 86% SO_2 removal and 87% limestone utilization. Considerable difficulties with control of venturi inlet pH at 5.5. Actual venturi inlet pH varied between 4.9 and 6.3, with wide variations in venturi and spray tower stoich. ratio. Mist eliminator was 3% restricted.	Excursion of venturi inlet pH occurred much less frequently during this run. Sulfite oxidation averaged 98%. SO_2 removal averaged 86% and limestone utilization 83%. Mist eliminator was about 3% restricted.	Sulfite oxidation averaged 97% with 82% limestone utilization and an overall SO_2 removal of 83%. The mist eliminator was only 1% restricted at the end of the run.	Sulfite oxidation averaged 98% with 81% limestone utilization. Average SO_2 removal was 86% at 2440 ppm inlet SO_2 concentration. The mist eliminator was 2% restricted at the end of the run.

Table E-2

SUMMARY OF FORCED-OXIDATION LIMESTONE TESTS ON THE TWO-LOOP VENTURI/SPRAY TOWER SYSTEM WITH AND WITHOUT MgO ADDITION

Run Number	819-1A	819-1B	820-1A	820-1B
Start-of-Run Date	11/1/77	12/8/77	3/1/78	4/4/78
End-of-Run Date	12/8/77	12/15/77	4/4/78	4/10/78
On Stream Hours	840	126	462	137
Fly Ash Loading	High	High	High	High
MgO Addition	No	No	Yes	Yes
Gas Rate, acfm @ 300°F	18,000 - 35,000	18,000 - 35,000	35,000	35,000
Spray Tower Gas Vel., ft/sec @ 125°F	4.8 - 9.4	4.8 - 9.4	9.4	9.4
Venturi Liquor Rate, gpm	600	600	600	600
Venturi L/G, gal/Mcf	21 - 42	21 - 42	21	21
Spray Tower Liquor Rate, gpm	1600	1600	1600	1600
Spray Tower L/G, gal/Mcf	57 - 111	57 - 111	57	57
Venturi Percent Solids Recirculated	13.0 - 16.9	13.8 - 16.6	12.1 - 16.8	13.4 - 15.6
Spray Tower Percent Solids Recirculated	8.1 - 11.9	8.6 - 10.5	3.8 - 8.2	7.6 - 8.9
Venturi Oxidation Tank Residence Time, min.	11.3	11.3	11.3	11.3
Venturi Desupersaturation Tank Residence Time, min.	4.7	4.7	4.7	4.7
Spray Tower Effluent Residence Time, min.	14.7	14.7	14.7	14.7
Solids Disposal System	Clar. & Fil./Lamella Settler	Clarifier & Filter	Clarifier & Filter	Clarifier & Filter
Stoichiometric Ratio in Venturi Inlet Slurry, moles Ca/mole SO_2	1.05 - 1.43	1.12 - 1.30	1.01 - 1.17[a]	1.02 - 1.19[c]
Stoichiometric Ratio in Spray Tower Inlet Slurry, moles Ca/mole SO_2	1.32 - 1.98	1.49 - 1.80	.88 - 1.43[b]	1.13 - 1.43[d]
Overall Avg. % Limestone Utilization, 100 x moles SO_2 abs./mole Ca added	81	83	92[a]	90[c]
Inlet O_2 Concentration, vol. %	5.9 - 8.7	6.8 - 10.0	6.0 - 8.3	6.0 - 6.8
Inlet SO_2 Concentration, ppm	2500 - 3400	2600 - 3400	1300 - 3200	1900 - 3100
Overall Percent SO_2 Removal	78 - 94	77 - 93	93 - 99	90 - 97
Average SO_2 Make-Per-Pass, mmole/l	3.5 - 9.5	4.6 - 10.3	7.3	7.6
Venturi Inlet pH Range	5.2 - 5.7	5.2 - 5.8	4.75 - 6.35	5.05 - 5.35
Venturi Outlet pH Range	4.3 - 4.7	4.2 - 4.7	4.0 - 5.7	4.80 - 5.05
Spray Tower Inlet pH Range	5.7 - 6.0	5.8 - 6.0	5.4 - 6.7	5.75 - 6.05
Spray Tower Outlet pH Range	5.4 - 6.0	5.6 - 5.8	---	---
Percent Sulfite Oxidized in Venturi Inlet Slurry	96 - 100	96 - 100	96 - 100	85 - 99
Percent Sulfite Oxidized in Spray Tower Inlet Slurry	10 - 32	15 - 22	15 - 45	7 - 26
Air Flow Rate to Oxidizer, scfm	210	210	210	150
Avg. Air Stoichiometric Ratio, lb-atoms oxygen/lb-mole SO_2 absorbed	1.45 - 2.80	1.45 - 2.80	1.70	1.10
Solids in Sludge Discharged, %	83 - 91	82 - 89	82 - 88	78 - 86
Calculated Avg. % Gypsum Saturation in Venturi Inlet Liquor @ 50°C	100	105	130	130
Calculated Avg. % Gypsum Saturation in Spray Tower Inlet Liquor @ 50°C	100	110	100	105
Total Dissolved Solids in Venturi Inlet Liquor, ppm	16,800 - 21,800	17,500 - 21,400	44,300 - 52,500	45,400 - 49,200
Total Dissolved Solids in Spray Tower Inlet Liquor, ppm	10,200 - 14,000	11,500 - 13,600	26,400 - 32,400	25,600 - 30,900
Total ΔP Range, Excluding Mist Elimination System, in. H_2O	5.8 - 15.9	10.8 - 14.3	14.0 - 17.3	14.7 - 16.9
Venturi ΔP, in. H_2O	3.0 - 9.3	5.5 - 9.1	9	9
Mist Elimination System ΔP Range, in. H_2O	0.18 - 0.86	0.24 - 0.82	0.52 - 0.68	0.58 - 0.66
Mist Elimination System Configuration	3-pass, open-vane, 316L SS chevron mist eliminator.	3-pass, open-vane, 316L SS chevron mist eliminator.	3-pass, open-vane, 316L SS chevron mist elimination.	3-pass, open-van, 316L SS chevron mist eliminator.
Mist Eliminator Wash Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.53 gpm/sq. ft.) with 7 min. off between nozzles. Bottom washed continuously using 4 nozzles with diluted clarified liquor (all available makeup water plus necessary clarified liquor) at 0.3 gpm/sq. ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.53 gpm/sq. ft.) with 7 min. off between nozzles. Bottom washed continuously using 4 nozzles with diluted clarified liquor (all available makeup water plus necessary clarified liquor) at 0.3 gpm/sq. ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.53 gpm/sq. ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available water plus necessary clarified liquor) through 4 nozzles at 0.4 gpm/sq. ft. (a) Total stoich. ratio for Ca & Mg is 1.03-1.19 (avg. alkali utilization = 90%). (b) Total stoich. ratio for Ca & Mg is 1.24-1.78 (avg. alkali utilization = 66%).	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.53 gpm/sq. ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) through 4 nozzles at 0.4 gpm/sq. ft. (c) Total stoich. ratio for Ca & Mg is 1.05-1.22 (avg. alkali utilization = 88%). (d) Total stoich. ratio for Ca & Mg is 1.32-1.62 (avg. alkali utilization = 68%).

Table E-2 (continued)

SUMMARY OF FORCED-OXIDATION LIMESTONE TESTS ON THE TWO-LOOP VENTURI/SPRAY TOWER SYSTEM WITH AND WITHOUT MgO ADDITION

Run Number	819-1A	819-1B	820-1A	820-1B
Oxidizer Design	A single 3-inch diameter 316L SS pipe which extends to the center of the oxidation tank and discharges air downward through an open elbow 3 inches from bottom of tank. Oxidation tank diameter is 8 ft. Tank slurry level was 18 ft.	A single 3-inch diameter 316L SS pipe which extends to the center of the oxidation tank and discharges air downward through an open elbow 3 inches from bottom of tank. Oxidation tank diameter is 8 ft. Tank slurry level was 18 ft.	A single 3-inch diameter 316L SS pipe which extends to the center of the oxidation tank and dicharges air downward through an open elbow 3 inches from bottom of tank. Oxidation tank diameter is 8 ft. Tank sluvry level was 18 ft.	A single 3-inch diameter 316L SS pipe which extends to the center of the oxidation tank and discharges air downward through an open elbow 3 inches from bottom of tank. Oxidation tank diameter is 8 ft. Tank slurry level was 18 ft.
Absorbent	Limestone slurried to 60 wt% with makeup water and added to spray tower hold tank.	Limestone slurried to 60 wt% with makeup water and added to spray tower hold tank.	Limestone slurried to 60 wt% with makeup water and added to spray tower EHT. MgO dry fed to spray tower EHT.	Limestone slurried to 60 wt% with makeup water and added to spray tower EHT. MgO dry fed to spray tower EHT.
Scrubber Internals	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.	Four sprays headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.
System Changes Before Start of Run	The outlet duct from the scrubber to reheater, areas above the mist eliminator, and the trap-out tray were cleaned. No other changes.	No changes. No cleaning.	Cleaned spray tower walls, headers, nozzles, outlet duct, Hauck reheater, and fan damper. Switched from lime to limestone.	(No shutdown.)
Method of Control	Venturi inlet pH controlled at 5.5 ± 0.2 by limestone addition to spray tower EHT. (Override: spray tower stoich. ratio ≤1.7.) Venturi recirculated slurry solids controlled at 15 ± 1%. Clarified liquor in excess of mist eliminator wash returned to oxidation tank. Venturi plug position fixed to give 9 in. H_2O pressure drop at 35,000 acfm gas rate.	Spray tower limestone stoichiometric ratio controlled at 1.6. Venturi recirculated slurry solids controlled at 15 ± 1%. Clarified liquor in excess of mist eliminator wash returned to oxidation tank. Venturi plug position fixed to give 9 in. H_2O pressure drop at 35,000 acfm gas rate.	Venturi inlet pH controlled at 5.5 ± 0.2 by limestone addition rate to the spray tower EHT. Venturi recirculated slurry solids controlled at 15 ± 1%. All clarified liquor in excess of mist eliminator bottom wash returned to the oxidation tank. Effective liquor Mg^{++} ion conc. (total ppm Mg^{++} - ppm Cl^-/2.92) in spray tower controlled at 5000 ppm.	Spray tower limestone stoichiometric ratio controlled at 1.6. Venturi recirculated slurry solids controlled at 15 ± 1%. All clarified liquor in excess of mist eliminator bottom wash returned to the oxidation tank. Effective liquor Mg^{++} ion conc. (total ppm Mg^{++} - ppm Cl^-/2.92) in spray tower controlled at 5000 ppm.
Run Philosophy	This was a one-month reliability test with forced oxidation. Test conditions were selected to meet EPA emission standards (1.2 lb SO_2 and 0.1 lb particulate per 10^6 Btu) and to give reliable scrubber and mist eliminator operation.	Extension of one-month reliability test 819-1A. Spray tower limestone stoichiometric ratio was controlled instead of venturi inlet pH to reduce pH and stoichiometry fluctuations.	The first two-stage forced oxidation test with MgO addition to observe if SO_2 removal efficiency can be improved. Also to see if good sulfite oxidation could be achieved and whether the spray tower could be operated in a gypsum-unsaturated mode. (cf Run 818-1A.)	Same as previous two-stage forced oxidation test with MgO addition except that the air flow rate was reduced to 150 scfm. The purpose was to observe whether near complete sulfite oxidation could be achieved at the lower air rate.
Results	Sulfite oxidation averaged 98%. SO_2 removal for the entire run averaged 86% at 2950 ppm inlet SO_2, which was higher than the 83% removal required to meet the emission standard. However, the standard was frequently exceeded for periods greater than the 3 hours allowed by EPA regulations. Average outlet mass loading was 0.042 gr/scf dry (0.021 - 0.063 range) which was better than the 0.052 gr/scf dry (at 30% excess air) required to meet the standard. Mist eliminator was 3% restricted at the end of the run (2% at the beginning).	Sulfite oxidation averaged 98%. SO_2 removal averaged 85% at 3000 ppm inlet SO_2. The mist eliminator was 3% restricted at the end of the run.	Gypsum saturation in spray tower inlet liquor averaged 100%. Average sulfite oxidation was 98%. SO_2 removal averaged 96% at 2250 ppm average inlet SO_2 concentration. The effective Mg^{++} ion concentration was 5150 ppm in spray tower and 8410 ppm in venturi. The scrubber was not shutdown at the end of the run.	Gypsum saturation in the spray tower inlet liquor averaged 105%. Average sulfite oxidation was 92%. SO_2 removal averaged 94% at 2500 ppm average inlet SO_2 concentration. The effective Mg^{++} ion concentration was 4985 ppm in the spray tower and 8035 ppm in the venturi. The mist eliminator was entirely clean at the end of the run.

Table E-2 (continued)

SUMMARY OF FORCED-OXIDATION LIMESTONE TESTS ON THE TWO-LOOP VENTURI/SPRAY TOWER SYSTEM WITH AND WITHOUT MgO ADDITION

Run Number	820-1C	822-1A	822-1B
Start-of-Run Date	4/13/78	4/25/78	5/5/78
End-of-Run Date	4/19/78	5/5/78	5/10/78
On Stream Hours	134	232	85
Fly Ash Loading	High	High	High
MgO Addition	Yes	Yes	Yes
Gas Rate, acfm @ 330°F	35,000	35,000	35,000
Spray Tower Gas Vel., ft/sec @ 125°F	9.4	9.4	9.4
Venturi Liquor Rate, gpm	600	600	600
Venturi L/G, gal/Mcf	21	21	21
Spray Tower Liquor Rate, gpm	1600	1600	1600
Spray Tower L/G, gal/Mcf	57	57	57
Venturi Percent Solids Recirculated	14.2 - 16.3	12.5 - 16.1	11.4 - 15.2
Spray Tower Percent Solids Recirculated	9.5 - 11.5	6.6 - 9.4	4.6 - 6.6
Venturi Oxidation Tank Residence Time, min.	11.3	11.3	11.3
Venturi Desupersaturation Tank Residence Time, min.	4.7	4.7	4.7
Spray Tower Effluent Residence Time, min.	14.7	14.7	14.7
Solids Disposal System	Clarifier & Filter	Clarifier & Filter	Clarifier & Filter
Stoichiometric Ratio in Venturi Inlet Slurry, moles Ca/mole SO2	1.14 - 1.27 (a)	0.96 - 1.56 (c)	0.99 - 1.17 (e)
Stoichiometric Ratio in Spray Tower Inlet Slurry, moles Ca/mole SO2	1.40 - 1.54 (b)	1.10 - 2.01 (d)	1.06 - 1.36 (f)
Overall Avg. % Limestone Utilization, 100 x moles SO2 abs./mole Ca added	(a) 85	(c) 79	(e) 93
Inlet O2 Concentration, vol. %	5.5 - 7.5	5.6 - 7.2	5.0 - 8.0
Inlet SO2 Concentration, ppm	2300 - 3700	2200 - 3300	1900 - 2900
Overall Percent SO2 Removal	85 - 97	83 - 99	85 - 95
Average SO2 Make-Per-Pass, m-mole/l	9.5	8.4	7.2
Venturi Inlet pH Range	4.65 - 4.95	4.7 - 5.7	4.7 - 5.4
Venturi Outlet pH Range	4.50 - 4.75	4.4 - 5.3	4.2 - 5.1
Spray Tower Inlet pH Range	5.75 - 6.05	5.5 - 6.0	5.45 - 5.8
Spray Tower Outlet pH Range	5.55 - 5.85	5.3 - 5.9	5.3 - 5.5
Percent Sulfite Oxidized in Venturi Inlet Slurry	29 - 41	94 - 99	96 - 99
Percent Sulfite Oxidized in Spray Tower Inlet Slurry	13 - 27	15 - 27	11 - 34
Air Flow Rate to Oxidizer, scfm	0	210	210
Avg. Air Stoichiometric Ratio, lb-atoms oxygen/lb-mole SO2 absorbed	0	1.45	1.70
Solids in Sludge Discharged, %	55 - 71	80 - 90	80 - 89
Calculated Avg. % Gypsum Saturation in Venturi Inlet Liquor @ 50°C	145	125	130
Calculated Avg. % Gypsum Saturation in Spray Tower Inlet Liquor @ 50°C	90	100	110
Total Dissolved Solids in Venturi Inlet Liquor, ppm	35,400 - 43,300	47,100 - 53,900	41,300 - 48,100
Total Dissolved Solids in Spray Tower Inlet Liquor, ppm	25,000 - 29,100	27,000 - 34,600	26,500 - 35,300
Total ΔP Range, Excluding Mist Elimination System, in. H2O	13.6 - 17.3	14.0 - 17.4	13.9 - 15.6
Venturi ΔP (nominal), in. H2O	9	9	9
Mist Elimination System ΔP Range, in. H2O	0.43 - 0.72	0.42 - 0.56	0.41 - 0.52
Mist Elimination System Configuration	3-pass, open-vane, 316L SS chevron mist eliminator.	3-pass, open-vane, 316L SS chevron mist eliminator.	3-pass, open-vane, 316L SS chevron mist eliminator.
Mist Eliminator Wash Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.53 gpm/sq.ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) through 4 nozzles at 0.4 gpm/sq.ft. (a) Total stoich. ratio for Ca & Mg is 1.22-1.33 (avg. alkali utilization = 79%). (b) Total stoich. ratio for Ca & Mg is 1.44-1.60 (avg. alkali utilization = 64%).	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.53 gpm/sq.ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) through 4 nozzles at 0.4 gpm/sq.ft. (c) Total stoich. ratio for Ca & Mg is 0.94-1.59 (avg. alkali utilization = 78%). (d) Total stoich. ratio for Ca & Mg is 1.23-2.14 (avg. alkali utilization = 59%).	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.53 gpm/sq.ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) through 4 nozzles at 0.4 gpm/sq.ft. (e) Total stoich. ratio for Ca & Mg is 1.01-1.19 (avg. alkali utilization = 91%). (f) Total stoich. ratio for Ca & Mg is 1.30-1.40 (avg. alkali utilization = 69%).

Note: Run 821-1A aborted.

Table E-2 (continued)

SUMMARY OF FORCED-OXIDATION LIMESTONE TESTS ON THE TWO-LOOP VENTURI/SPRAY TOWER SYSTEM WITH AND WITHOUT MgO ADDITION

Run Number	820-1C	822-1A	822-1B
Oxidizer Design	A single 3-inch diameter 316L SS pipe which extends to the center of the oxidation tank and discharges air downward through an open elblow 3 inches from bottom of tank. Oxidation tank diameter is 8 ft. Tank slurry level was 18 ft.	A single 3-inch diameter 316L SS pipe which extends to the center of the oxidation tank and discharges air downward through an open elbow 3 inches from bottom of tank. Oxidation tank diameter is 8 ft. Tank slurry level was 18 ft.	A single 3-inch diameter 316L SS pipe which extends to the center of the oxidation tank and discharges air downward through an open elbow 3 inches from bottom of tank. Oxidation tank diameter is 8 ft. Tank slurry level was 18 ft.
Absorbent	Limestone slurried to 60 wt% with makeup water and added to spray tower EHT. MgO dry fed to spray tower EHT.	Limestone slurried to 60 wt% with makeup water and added to spray tower EHT. MgO dry fed to spray tower EHT.	Limestone slurried to 60 wt% with makeup water and added to spray tower EHT. MgO dry fed to spray tower EHT.
Scrubber Internals	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.
System Changes Before Start of Run	Cleaned downcomer, venturi return liquor pipe, Hauck reheater shell, I.D. fan and damper. No other changes.	No changes. No cleaning.	(No shutdown.)
Method of Control	Spray tower limestone stoichiometric ratio controlled at 1.6. Venturi recirculated slurry solids controlled at 15 ± 1%. All clarified liquor in excess of mist eliminator bottom wash returned to the oxidation tank. Effective liquor Mg^{++} ion conc. (total ppm Mg^{++} - ppm Cl^-/2.92) in spray tower controlled at 5000 ppm.	Spray tower limestone stoichiometric ratio controlled at 1.6. Venturi recirculated slurry solids controlled at 15 ± 1%. All clarified liquor in excess of mist eliminator bottom wash returned to the oxidation tank. Effective liquor Mg^{++} ion conc. (total ppm Mg^{++} - ppm Cl^-/2.92) in spray tower controlled at 5000 ppm.	Spray tower limestone stoichiometric ratio controlled at 1.6. Venturi recirculated slurry solids controlled at 15 ± 1%. All clarified liquor in excess of mist eliminator bottom wash returned to the oxidation tank. Effective liquor Mg^{++} ion conc. (total ppm Mg^{++} - ppm Cl^-/2.92) in spray tower controlled at 5000 ppm.
Run Philosophy	Same as previous two-stage forced oxidation test with MgO addition except that the air flow rate was reduced to zero. The purpose was to determine the base case sulfite oxidation and SO_2 removal when oxidation is not forced.	The purpose of the run was to observe whether SO_2 removal efficiency could be improved when the spray tower bleed, which has high liquor $SO_3^=$ concentration is introduced directly to the venturi scrubber, instead of the oxidation tank (cf. Run 820-1A).	The run was made at the same conditions as Run 822-1A except the spray tower recirculation slurry was turned off for 30 min. every 8 hours to determine the SO_2 removal by venturi alone.
Results	Gypsum saturation in the spray tower inlet liquor averaged 30%. Average sulfite oxidation was 36%. SO_2 removal averaged 91% at 2750 ppm average inlet SO_2 concentration. The effective Mg^{++} ion concentration was 4700 ppm in the spray tower and 7815 ppm in the venturi. The mist eliminator was entirely clean at the end of the run.	Average sulfite oxidation was 97%. SO_2 removal averaged 91% at 2750 ppm average inlet SO_2 concentration. The effective Mg^{++} ion concentration was 4895 ppm in the spray tower and 8110 ppm in the venturi. The scrubber was not shut down at the end of the run.	Average sulfite oxidation was 98%. SO_2 removal averaged 90% for venturi and spray tower and 29% for venturi alone at 2400 ppm average inlet SO_2 concentration. The effective Mg^{++} ion concentration was 4845 ppm in spray tower and 7220 ppm in the venturi. The mist eliminator was entirely clean at the end of the run.

Note: Run 821-1A aborted.

Table E-3

SUMMARY OF LIMESTONE/MgO TESTS ON THE VENTURI/SPRAY TOWER WITH BLEEDSTREAM OXIDATION

Run Number	823-1A	824-1A	825-1A
Start-of-Run Date	5/12/78	5/23/78	5/30/78
End-of-Run Date	5/23/78	5/30/78	6/9/78
On Stream Hours	205	159	229
Fly Ash Loading	High	High	High
MgO Addition	Yes	Yes	Yes
Gas Rate, acfm @ 300°F	18,000	35,000	18,000
Spray Tower Gas Vel., ft/sec @ 125°F	4.8	9.4	4.8
Venturi Liquor Rate, gpm	600	600	600
Venturi L/G, gal/Mcf	42	21	42
Spray Tower Liquor Rate, gpm	1600	1600	1600
Spray Tower L/G, gal/Mcf	111	57	111
Percent Solids Recirculated	11.0 - 15.6	12.9 - 15.3	13.4 - 16.0
Effluent Hold Tank Residence Time, min	11.2	11.2	11.2
Oxidation Tank Level, ft	18	18	18
Stoichiometric Ratio, moles Ca added/mole SO_2 absorbed	1.63 - 3.88[a]	1.53 - 3.73[b]	1.20 - 1.92[c]
Avg. % Limestone Utilization, 100 x moles SO_2 abs./mole Ca added	36[a]	38[b]	64[c]
Inlet O_2 Concentration, vol. %	6.6 - 9.0	6.0 - 8.6	6.0 - 8.5
Inlet SO_2 Concentration, ppm	2400 - 2800	2300 - 2900	2200 - 2800
Percent SO_2 Removal	90 - 98	80 - 96	92 - 98
Average SO_2 Make-Per-Pass, m-mole/l	4.0	7.6	4.0
Scrubber Inlet pH Range	4.95 - 5.55	5.00 - 5.50	5.0 - 5.9
Venturi Outlet pH Range	4.40 - 5.30	4.50 - 5.00	4.7 - 5.4
Spray Tower Outlet pH Range	4.95 - 5.70	4.80 - 5.50	5.0 - 5.7
Oxidation Tank pH Range	5.95 - 6.65	5.80 - 6.00	5.3 - 6.0
Percent Sulfite Oxidized in Scrubber Inlet Slurry	78 - 94	24 - 74	27 - 51
Percent Sulfite Oxidized in Oxidation Tank	96 - 99	95 -99	95 - 99
Air Flow Rate to Oxidizer, scfm	110	210	110
Avg. Air Stoichiometric Ratio, lb-atoms oxygen/lb-mole SO_2 absorbed	1.55	1.60	1.60
Solids Disposal System	Clarifier & Filter	Clarifier & Filter	Clarifier & Filter
Solids in Sludge Discharged, %	79 - 87	80 - 90	82 - 88
Calculated Avg. % Gypsum Saturation in Scrubber Inlet Liquor @ 50°C	120	85	105
Calculated Avg. % Gypsum Saturation in Oxidation Tank @ 50°C	115	90	115
Total Dissolved Solids in Scrubber Inlet Liquor, ppm	29,400 - 33,800	28,500 - 36,100	31,300 - 37,900
Total Dissolved Solids in Oxidation Tank, ppm	27,100 - 31,300	26,900 - 34,500	31,700 - 37,600
Total ΔP Range, Excluding Mist Elimination System, in. H_2O	11.3 - 12.6	14.6 - 17.6	10.0 - 13.7
Venturi ΔP (nominal), in. H_2O	9	9	9
Mist Elimination System ΔP Range, in. H_2O	0.14 - 0.23	0.39 - 0.62	0.17 - 0.34
Mist Elimination System Configuration	3-pass, open-vane, 316L SS chevron mist eliminator.	3-pass, open-vane, 316L SS chevron mist eliminator.	3-pass, open-vane, 316L SS chevron mist eliminator.
Mist Eliminator Wash Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.53 gpm/sq.ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) through 4 nozzles at 0.3 gpm/sq.ft. (a) Total stoich. ratio for Ca & Mg is 1.66-3.91 (avg. alkali utilization = 36%).	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.53 gpm/sq.ft.) with 7 min. off between nozzles. Bottom washed continuously with dilutec clarified liquor (all available makeup water plus necessary clarified liquor) through 4 nozzles at 0.4 gpm/sq.ft. (b) Total stoich. ratio for Ca & Mg is 1.55-3.75 (avg. alkali utilization = 38%).	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.53 gpm/sq.ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liqour) through 4 nozzles at 0.3 gpm/sq.ft. (c) Total stoich. ratio for Ca & Mg is 1.21-1.93 (avg. alkali utilization = 64%).

Table E-3 (continued)

SUMMARY OF LIMESTONE/MgO TESTS ON THE VENTURI/SPRAY TOWER WITH BLEEDSTREAM OXIDATION

Run Number	823-1A	824-1A	825-1A
Oxidizer Design	A single EHT was used for both the venturi and the spray tower. A slurry stream was taken from the scrubber downcomer to the oxidation tank with a 30 gpm recycle from the oxidation tank back to EHT. Final system bleed taken from oxidation tank to clarifier. Oxidizer is a single 3-inch diameter 316L SS pipe which extends to the center of the oxidation tank and discharges air downward through an open elbow 3 inches from the bottom of the tank. Oxidation tank diameter is 8 ft. Tank slurry level was 18 ft.	A single EHT was used for both the venturi and the spray tower. A slurry stream was taken from the scrubber downcomer to the oxidation tank with a 30 gpm recycle from the oxidation tank back to EHT. Final system bleed taken from oxidation tank to clarifier. Oxidizer is a single 3-inch diameter 316L SS pipe which extends to the center of the oxidation tank and discharges air downward through an open elbow 3 inches from the bottom of the tank. Oxidation tank diameter is 8 ft. Tank slurry level was 18 ft.	A single EHT was used for both the venturi and the spray tower. System bleed stream was taken from the scrubber downcomer and sent to the oxidation tank for oxidation before being discharged to the clarifier. Oxidizer is a single 3-inch diameter 316L SS pipe which extends to the center of the oxidation tank and discharges air downward through an open elbow 3 inches from the bottom of the tank. Oxidation tank diameter is 8 ft. Tank slurry level was 18 ft.
Absorbent	Limestone slurried to 60 wt% with makeup water and added to EHT. MgO dry fed to EHT.	Limestone slurried to 60 wt% with makeup water and added to EHT. MgO dry fed to EHT.	Limestone slurried to 60 wt% with makeup water and added to EHT. MgO dry fed to EHT.
Scrubber Internals	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.
System Changes Before Start of Run	Modified the system for bleed stream oxidation. Used a common tank EHT (D-101) for both venturi and spray tower. Installed an overflow line from oxidation tank (D-108) to EHT (D-101). No cleaning.	Cleaned I.D. fan and replaced I.D. fan outboard bearing. No other changes.	Cleaned trap out tray, lower part of spray nozzles and venturi plug. No other changes.
Method of Control	Scrubber inlet slurry pH controlled at 5.2 - 5.3. Recirculated slurry solids controlled at 15 ± 1%. All clarified liquor in excess of mist eliminator bottom wash returned to the EHT. Effective Mg++ ion concentration (total ppm Mg++ - ppm $Cl^-/2.92$) in scrubber inlet liquor controlled at 5000 ppm.	Scrubber limestone stoichiometric ratio controlled at 1.9. Recirculated slurry solids controlled at 15 ± 1%. All clarified liquor in excess of mist eliminator bottom wash returned to the EHT. Effective Mg++ ion concentration (total ppm Mg++ - ppm $Cl^-/2.92$) in scrubber inlet liquor controlled at 5000 ppm.	Scrubber solids limestone stoichiometric ratio controlled at 1.4. Recirculated slurry solids controlled at 15 ± 1%. All clarified liquor in excess of mist eliminator bottom wash returned to the EHT. Effective Mg^{++} ion concentration (total ppm Mg^{++} -ppm$Cl^-/2.92$) in scrubber inlet liquor controlled at 5000 ppm.
Run Philosophy	The purpose of this run was to observe whether near complete sulfite oxidation and good quality solids could be obtained with the bleed stream forced oxidation.	The purpose of this run was to observe whether the solids quality would deteriorate with reduced solids residence time in the oxidation tank (increased gas rate and solids production rate).	The purpose of this run was to observe the effect of stopping the 30 gpm recycle from the oxidation tank to the EHT on oxidation tank pH and sulfite oxidation (cf. Run 823-1A).
Results	Average sulfite oxidation in the oxidation tank was 98%. SO_2 removal averaged 94% at 2600 ppm average inlet SO_2 concentration. The effective Mg++ ion concentration was 4990 ppm in the scrubber inlet liquor. Filter cake solids averaged 83%. The mist eliminator was entirely clean at the end of the run.	Average sulfite oxidation was 97%. SO_2 removal averaged 88% at 2600 ppm average inlet SO_2 concentration. The effective Mg++ ion concentration was 5215 ppm in the scrubber inlet liquor. Filter cake solids averaged 85%. The mist eliminator was entirely clean at the end of the run.	Average sulfite oxidation in the oxidation tank was 97%. SO_2 removal averaged 95% at 2500 ppm average inlet SO_2 concentration. The effective Mg^{++} ion concentration was 5380 ppm in the scrubber inlet liquor. Filter cake solids averaged 86%. The mist eliminator was 0.5% restricted at the end of the run.

Table E-3 (continued)

SUMMARY OF LIMESTONE/MgO TESTS ON THE VENTURI/SPRAY TOWER WITH BLEEDSTREAM OXIDATION

Run Number	826-1A	
Start-of-Run Date	6/9/78	
End-of-Run Date	6/19/78	
On Stream Hours	246	
Fly Ash Loading	High	
MgO Addition	Yes	
Gas Rate, acfm @ 300°F	26,500	
Spray Tower Gas Vel., ft/sec @ 125°F	7.1	
Venturi Liquor Rate, gpm	600	
Venturi L/G, gal/Mcf	28	
Spray Tower Liquor Rate, gpm	1600	
Spray Tower L/G, gal/Mcf	75	
Percent Solids Recirculated	14.6 - 15.8	
Effluent Hold Tank Residence Time, min.	11.2	
Oxidation Tank Level, ft	18	
Stoichiometric Ratio, moles Ca added/mole SO_2 absorbed	1.10 - 2.18[a]	
Avg. % Limestone Utilization, 100 x moles SO_2 abs./mole Ca added	61[a]	
Inlet O_2 Concentration, vol. %	7.5 - 8.5	
Inlet SO_2 Concentration, ppm	2200 - 3300	
Percent SO_2 Removal	82 - 96	
Average SO_2 Make-Per-Pass, m-mole/l	6.3	
Scrubber Inlet pH Range	5.1 - 5.6	
Venturi Outlet pH Range	4.8 - 5.2	
Spray Tower Outlet pH Range	5.1 - 5.5	
Oxidation Tank pH Range	5.1 - 5.8	
Percent Sulfite Oxidized in Scrubber Inlet Slurry	14 - 44	
Percent Sulfite Oxidized in Oxidation Tank	93 - 99	
Air Flow Rate to Oxidizer, scfm	210	
Avg. Air Stoichiometric Ratio, lb-atoms oxygen/lb-mole SO_2 absorbed	2.0	
Solids Disposal System	Clarifier & Filter	
Solids in Sludge Discharged, %	80 - 88	
Calculated Avg. % Gypsum Saturation in Scrubber Inlet Liquor @ 50°C	105	
Calculated Avg. % Gypsum Saturation in Oxidation Tank @ 50°C	115	
Total Dissolved Solids in Scrubber Inlet Liquor, ppm	29,100 - 37,100	
Total Dissolved Solids in Oxidation Tank, ppm	29,000 - 36,800	
Total ΔP Range, Excluding Mist Elimination System, in. H_2O	12.2 - 14.4	
Venturi ΔP (nominal), in. H_2O	9	
Mist Elimination System ΔP Range, in. H_2O	0.39 - 0.54	
Mist Elimination System Configuration	3-pass, open-vane, 316L SS chevron mist eliminator.	
Mist Eliminator Wash Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.53/gpm/sq.ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) through 4 nozzles at 0.4 gpm/sq.ft. [a] Total stoich. ratio for Ca & Mg is 1.11-2.19 (avg. alkali utilization = 61%)	

Table E-3 (continued)

SUMMARY OF LIMESTONE/MgO TESTS ON THE VENTURI/SPRAY TOWER WITH BLEEDSTREAM OXIDATION

Run Number	826-1A	
Oxidizer Design	A single EHT was used for both the venturi and the spray tower. System bleed stream was taken from the scrubber downcomer and sent to the oxidation tank for oxidation before being discharged to the clarifier. Oxidizer is a single 3-inch diameter 316L SS pipe which extends to the center of the oxidation tank and discharges air downward through an open elbow 3 inches from the bottom of the tank. Oxidation tank diameter is 8 ft. Tank slurry level was 18 ft.	
Absorbent	Limestone slurried to 60 wt% with makeup water and added to EHT. MgO dry fed to EHT.	
Scrubber Internals	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.	
System Changes Before Start of Run	Cleaned venturi scrubber walls in guide vanes area. No other changes.	
Method of Control	Scrubber solids limestone stoichiometric ratio controlled at 1.4. Recirculated slurry solids controlled at 15±1%. All clarified liquor in excess of mist eliminator bottom wash returned to the EHT. Effective Mg^{++} ion concentration (total ppm Mg^{++}-ppm $Cl^-/2.92$) in scrubber inlet liquor controlled at 5000 ppm.	
Run Philosophy	The purpose of this run was to observe whether the waste solids quality would deteriorate with reduced solids residence time in the oxidation tank (increased gas rate and solids production rate) and without the 30 gpm recycle from the oxidation tank to the EHT.	
Results	Average sulfite oxidation in the oxidation tank was 96%. SO_2 removal averaged 89% at 2750 ppm average inlet SO_2 concentration. The effective Mg^{++} ion concentration was 4970 ppm in the scrubber inlet liquor. Filter cake solids averaged 84%. The mist eliminator was 0.1% restricted at the end of the run.	

Table E-4

SUMMARY OF FORCED-OXIDATION TESTS ON THE TWO-LOOP VENTURI/SPRAY TOWER SYSTEM

Run Number	851-1A	852-1A	853-1A	854-1A
Start-of-Run Date	3/10/77	3/15/77	3/18/77	3/25/77
End-of-Run Date	3/15/77	3/18/77	3/25/77	4/ 1/77
On Stream Hours	110	74	161	166
Fly Ash	Yes	Yes	Yes	Yes
MgO Addition	No	No	No	No
Gas Rate, acfm at 300°F	25,000	25,000	25,000	25,000
Spray Tower Gas Vel., ft/sec @ 125°F	6.7	6.7	6.7	6.7
Venturi Liquor Rate, gpm	600	min. (~160)	600	600
Venturi L/G, gal/Mcf	30	8	30	30
Spray Tower Liquor Rate, gpm	1400	1400	1400	1400
Spray Tower L/G, gal/Mcf	70	70	70	70
Venturi Percent Solids Recirculated	13.9 - 16.5	14.6 - 17.0	13.9 - 16.5	13.8 - 16.6
Spray Tower Percent Solids Recirculated	5.6 - 6.3	6.4 - 10.1	5.9 - 6.9	5.5 - 6.7
Venturi Oxidation Tank Residence Time, min.	11.3	42	11.3	11.3
Venturi Desupersaturation Tank Residence Time, min.	4.7	17.7	4.7	4.7
Spray Tower Effluent Residence Time, min.	18	18	18	18
Solids Disposal System	Clarifier & Filter	Clarifier & Filter	Clarifier & Filter	Clarifier & Filter
Stoichiometric Ratio in Venturi Inlet Slurry, moles Ca/mole SO_2	1.01 - 1.03	1.02 - 1.07	1.01 - 1.10	1.00 - 1.07
Stoichiometric Ratio in Spray Tower Inlet Slurry, moles Ca/mole SO_2	1.09 - 1.17	1.10 - 1.15	1.09 - 1.19	1.14 - 1.16
Overall Avg. % Lime Utilization, 100x moles SO_2 abs./mole Ca added	98	96	95	97
Inlet SO_2 Concentration, ppm	2700 - 3900	3000 - 3600	3100 - 3600	2800 - 3600
Inlet O_2 Concentration, vol. %	5.2 - 6.7	4.5 - 7.1	4.1 - 6.1	4.5 - 5.9
Overall Percent SO_2 Removal	74 - 82	64 - 76	72 - 82	74 - 90
Avg. SO_2 Make-per-pass, m-mole/l	6.8	6.5	7.0	7.0
Venturi Inlet pH Range	4.4 - 4.65	4.6 - 5.2	4.3 - 5.2	4.8 - 5.4
Venturi Outlet pH Range	—	—	—	5.2 - 4.4
Spray Tower Inlet pH Range	7.7 - 8.3	7.6 - 8.3	7.7 - 8.3	7.8 - 8.3
Spray Tower Outlet pH Range	—	—	4.2 - 5.1	5.3 - 5.9
Percent Sulfite Oxidized in Venturi Inlet Slurry	95 - 99	88 - 100	96 - 99	92 - 99
Percent Sulfite Oxidized in Spray Tower Inlet Slurry	7 - 22	6 - 23	8 - 20	5 - 17
Air Flow Rate to Oxidizer, acfm	160	150	150	150
Avg. Air Stoichiometric Ratio, lb-atoms oxygen/lb-mole SO_2 absorbed	1.45	1.55	1.60	1.60
Solids in Sludge Discharged, %	76 - 88	65 - 80	73 - 83	75 - 83
Calculated Avg. % Gypsum Saturation in Venturi Inlet Liquor @ 50°C	95	104	100	100
Calculated Avg. % Gypsum Saturation in Spray Tower Inlet Liquor @ 50°C	60	60	60	55
Total Dissolved Solids in Venturi Inlet Liquor, ppm	5900 - 9200	9200 - 10,400	9400 - 10,600	9000 - 11,000
Total Dissolved Solids in Spray Tower Inlet Liquor, ppm	5900 - 6800	3600 - 6600	6200 - 7700	5500 - 7500
Total ΔP Range, Excluding Mist Elimination System, in. H_2O	10.3 - 11.2	3.3 - 6.7	6.1 - 7.0	10.2 - 11.2
Venturi ΔP, in. H_2O	9	1.7-3.5 (Plug 100% open)	4.4-5.0 (Plug 100% open)	9
Mist Elimination System ΔP Range, in. H_2O	0.24 - 0.30	0.23 - 0.29	0.24 - 0.30	0.24 - 0.30
Mist Elimination System Configuration	3-pass, open-vane, 316L SS chevron mist eliminator.	3-pass, open-vane, 316L SS chevron mist eliminator.	3-pass, open-vane, 316L SS chevron mist eliminator.	3-pass, open-vane, 316L SS chevron mist eliminator.
Mist Eliminator Washing Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on 4 minutes (at 0.53 gpm/sq. ft.) with 76 minutes off between nozzles. Bottom washed intermittently with makeup water at 1.5 gpm/sq. ft. for 6 minutes every 4 hours.	Top washed sequentially with makeup water. Each nozzle (6 total) on 4 minutes (at 0.53 gpm/sq. ft.) with 76 minutes off between nozzles. Bottom washed intermittently with makeup water at 1.5 gpm/sq. ft. for 6 minutes every 4 hours.	Top washed sequentially with makeup water. Each nozzle (6 total) on 4 minutes (at 0.53 gpm/sq. ft.) with 76 minutes off between nozzles. Bottom washed intermittently with makeup water at 1.5 gpm/sq. ft. for 6 minutes every 4 hours.	Top washed sequentially with makeup water. Each nozzle (6 total) on 4 minutes (at 0.53 gpm/sq. ft.) with 76 minutes off between nozzles. Bottom washed intermittently with makeup water at 1.5 gpm/sq. ft. for 6 minutes every 4 hours.

Table E-4 (continued)

SUMMARY OF FORCED-OXIDATION LIME TESTS ON THE TWO-LOOP VENTURI/SPRAY TOWER SYSTEM

Run Number	851-1A	852-1A	853-1A	854-1A
Oxidizer Design	Octagonal sparger ring with 130 1/8 inch diameter holes on bottom side. Sparger ring made of 3 inch 316L SS pipe with 21.5 inch sides and located 6 inches from tank bottom. Oxidation tank diameter is 8 ft.	Octagonal sparger ring with 130 1/8 inch diameter holes on bottom side. Sparger ring made of 3 inch 316L SS pipe with 21.5 inch sides and located 6 inches from tank bottom. Oxidation tank diameter is 8 ft.	Octagonal sparger ring with 130 1/8 inch diameter holes on bottom side. Sparger ring made of 3 inch 316L SS pipe with 21.5 inch sides and located 6 inches from tank bottom. Oxidation tank diameter is 8 ft.	Octagonal sparger ring with 130 1/8 inch diameter holes on bottom side. Sparger ring made of 3 inch 316L SS pipe with 21.5 inch sides and located 6 inches from tank bottom. Oxidation tank diameter is 8 ft.
Absorbent	Lime slaked to 20 wt% slurry with makeup water and added to venturi downcomer and spray tower hold tank.	Lime slaked to 20 wt% slurry with makeup water and added to venturi downcomer and spray tower hold tank.	Lime slaked to 20 wt% slurry with makeup water and added to venturi downcomer and spray tower hold tank.	Lime slaked to 20 wt% slurry with makeup water and added to venturi downcomer and spray tower hold tank.
Scrubber Internals	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.
System Changes before Start of Run	Mist eliminator was cleaned prior to the run. Installed separate lime feed systems for venturi and spray tower slurry loops.	No cleaning. No changes.	(No shutdown.)	No cleaning. No changes.
Method of Control	Venturi inlet pH controlled at 4.5 ± 0.2 and spray tower inlet pH at 8.0 ± 0.2 by separate lime additions. Venturi recirculated slurry solids controlled at 15 ± 1%. Clarified liquor returned to both oxidation tank and spray tower EHT.	Venturi inlet pH controlled at 4.5 or higher and spray tower inlet pH at 8.0 ± 0.2 by separate lime additions. Venturi recirculated slurry solids controlled at 15 ± 1%. Clarified liquor returned to both oxid. tank and spray tower EHT.	Venturi inlet pH controlled at 4.5 or higher and spray tower inlet pH at 8.0 ± 0.2 by separate lime additions. Venturi recirculated slurry solids controlled at 15 ± 1%. Clarified liquor returned to spray tower EHT.	Venturi inlet pH controlled at 5.2 ± 0.2 and spray tower inlet pH at 8.0 ± 0.2 by separate lime additions. Venturi recirculated slurry solids controlled at 15 ± 1%. Clarified liquor returned to spray tower EHT.
Run Philosophy	First two-stage forced oxidation run with lime scrubbing. Test conditions chosen to achieve complete sulfite oxidation and satisfactory SO_2 removal.	To minimize the amount of lime needed to maintain the venturi inlet pH at 4.5 or higher by reducing the SO_2 removal in the venturi scrubber with minimum slurry flow and 100% open plug.	To increase the amount of SO_2 absorption in the venturi (900 gpm and 100% open plug) so that the venturi inlet pH remains below 6.0.	To observe the effect of the higher oxidation pH of 5.2 on sulfite oxidation and slurry dewatering characteristics.
Results	Sulfite oxidation averaged 97% with 78% SO_2 removal. Independent venturi and spray tower inlet pH control was necessary to avoid wide pH fluctuations. The mist eliminator was 1% restricted.	Overall sulfite oxidation was 83% and SO_2 removal 70% (cf. 97 and 78%, respectively, for Run 851-1A). The venturi inlet pH rose to about 6.0 toward the end of the run, resulting in poor sulfite oxidation. The scrubber was not shut down at the end of the run.	SO_2 removal increased to 77% (cf. 70% for Run 852-1A). Sulfite oxidation remained high at 97%. Lime utilization averaged 96%. The mist eliminator was 1% restricted.	Sulfite oxidation averaged 96% with 82% SO_2 removal and 97% lime utilization (cf. 97, 77 and 96%, respectively, for Run 853-1A). The average solids in the discharge cake was 79% (cf. 78% for Run 853-1A). Mist eliminator remained 1% restricted.

Table E-4 (continued)

SUMMARY OF FORCED-OXIDATION LIME TESTS ON THE TWO-LOOP VENTURI/SPRAY TOWER SYSTEM

Run Number	855-1A	856-1A	857-1A	858-1A
Start-of-Run Date	4/21/77	4/28/77	5/3/77	5/14/77
End-of-Run Date	4/28/77	5/2/77	5/12/77	5/20/77
On-Stream Hours	158	209	128	142
Fly Ash	No	No	No	No
MgO Addition	No	No	No	No
Gas Rate, acfm @ 300°F	25,000	25,000	25,000	25,000
Spray Tower Gas Vel., ft/sec @ 125°F	6.7	6.7	6.7	6.7
Venturi Liquor Rate, gpm	600	600	600	600
Venturi L/G, gal/Mcf	30	30	30	30
Spray Tower Liquor Rate, gpm	1400	1400	1400	1400
Spray Tower L/G, gal/Mcf	70	70	70	70
Venturi Percent Solids Recirculated	12.9 - 15.4	14.2 - 15.4	13.4 - 15.2	6.8 - 8.2
Spray Tower Percent Solids Recirculated	6.8 - 7.7	7.6 - 8.2	7.3 - 8.4	13.4 - 15.5
Venturi Oxidation Tank Residence Time, min.	11.3	11.3	11.3	11.3
Venturi Desupersaturation Tank Residence Time, min.	4.7	4.7	4.7	4.7
Spray Tower Effluent Residence Time, min.	18	18	18	18
Solids Disposal System	Clarifier & Filter	Clarifier & Filter	Clarifier & Filter	Clarifier & Filter
Stoichiometric Ratio in Venturi Inlet Slurry, moles Ca/mole SO_2	1.01 - 1.05	1.00 - 1.04	1.00 - 1.02	1.00 - 1.04
Stoichiometric Ratio in Spray Tower Inlet Slurry, moles Ca/mole SO_2	1.11 - 1.16	1.14 - 1.18	1.12 - 1.15	1.12 - 1.15
Overall Avg. % Lime Utilization, 100 x moles SO_2 abs./mole Ca added	98	98	98	98
Inlet O_2 Concentration, vol. %	5.5 - 11.5	7.8 - 8.8	8.7 - 9.3	6.4 - 7.8
Inlet SO_2 Concentration, ppm	1600 - 3100	2300 - 2700	2500 - 2800	2400 - 3100
Overall Percent SO_2 Removal	76 - 89	84 - 92	81 - 87	79 - 87
Average SO_2 Make-per-pass, mmole/l	5.2	6.0	6.0	6.0
Venturi Inlet pH Range	4.4 - 5.0	4.7 - 5.3	5.1 - 5.7	6.1 - 6.7
Venturi Outlet pH Range	2.7 - 3.4	3.0 - 3.9	3.8 - 4.5	3.3 - 4.0
Spray Tower Inlet pH Range	7.8 - 8.1	7.8 - 8.2	7.8 - 8.3	7.9 - 8.2
Spray Tower Outlet pH Range	---	---	---	8.3 - 8.6
Percent Sulfite Oxidized in Venturi Inlet Slurry	97 - 99	95 - 99	96 - 98	96 - 100
Percent Sulfite Oxidized in Spray Tower Inlet Slurry	13 - 23	6 - 18	5 - 17	5 - 21
Air Flow Rate to Oxidizer, scfm	150	150	150	150
Avg. Air Stoichiometric Ratio, lb-atoms oxygen/lb-mole SO_2 absorbed	1.90	1.68	1.55	1.60
Solids in Sludge Discharged, %	62 - 88	76 - 90	78 - 86	72 - 90
Calculated Avg. % Gypsum Saturation in Venturi Inlet Liquor @ 50°C	106	98	100	110
Calculated Avg. % Gypsum Saturation in Spray Tower Inlet Liquor @ 50°C	66	90	90	85
Total Dissolved Solids in Venturi Inlet Liquor, ppm	3800 - 4900	6100 - 7400	7600 - 9100	4400 - 12,200
Total Dissolved Solids in Spray Tower Inlet Liquor, ppm	2700 - 3500	3100 - 4500	4000 - 4800	1700 - 4700
Total ΔP Range, Excluding Mist Elimination System, in. H_2O	11.1 - 12.2	11.5 - 12.7	11.4 - 12.0	11.4 - 11.9
Venturi ΔP (nominal), in. H_2O	9	9	9	9
Mist Elimination System ΔP Range, in. H_2O	0.32 - 0.36	0.31 - 0.36	0.31 - 0.34	0.31 - 0.34
Mist Elimination System Configuration	1-pass, open-vane, 316L SS chevron mist eliminator.	1-pass, open-vane, 316L SS chevron mist eliminator.	1-pass, open-vane, 316L SS chevron mist eliminator.	1-pass, open-vane 316L SS chevron mist eliminator.
Mist Eliminator Wash Scheme	Top washed sequentially with makeup water. Each nozzle is (total) on 4 min. (at 0.53 gpm/sq. ft.) with 76 min. off between nozzles. Bottom washed intermittently with makeup water through 10 nozzles at 1.5 gpm/sq. ft. for 4 min. every 4 hours.	Top washed sequentially with makeup water. Each nozzle is (total) on 4 min. (at 0.53 gpm/sq. ft.) with 76 min. off between nozzles. Bottom washed intermittently with makeup water through 10 nozzles at 1.5 gpm/sq. ft. for 4 min. every 4 hours.	Top washed sequentially with makeup water. Each nozzle is (total) on 4 min. (at 0.53 gpm/sq. ft.) with 76 min. off between nozzles. Bottom washed intermittently with makeup water through 10 nozzles at 1.5 gpm/sq. ft. for 4 min. every 4 hours.	Top washed sequentially with makeup water. Each nozzle is (total) on 4 min. (at 0.53 gpm/sq. ft.) with 76 min. off between nozzles. Bottom washed intermittently with makeup water through 10 nozzles at 1.5 gpm/sq. ft. for 4 min. every 4 hours.

Table E-4 (continued)

SUMMARY OF FORCED-OXIDATION LIME TESTS ON THE TWO-LOOP VENTURI/SPRAY TOWER SYSTEM

Run Number	855-1A	856-1A	857-1A	858-1A
Oxidizer Design	Octagonal sparger ring with 40 1/4 inch diameter holes on bottom side. Sparger ring made of 3 inch 316L SS pipe with 21.5 inch sides and located 6 inches from tank bottom. Oxidation tank diameter is 8 ft. Tank slurry level was 18 ft.	Octagonal sparger ring with 40 1/4 inch diameter holes on bottom side. Sparger ring made of 3 inch 316L SS pipe with 21.5 inch sides and located 6 inches from tank bottom. Oxidation tank diameter is 8 ft. Tank slurry level was 18 ft.	Octagonal sparger ring with 40 1/4 inch diameter holes on bottom side. Sparger ring made of 3 inch 316L SS pipe with 21.5 inch sides and located 6 inches from tank bottom. Oxidation tank diameter is 8 ft. Tank slurry level was 18 ft.	Octagonal sparger ring with 40 1/4 inch diameter holes on bottom side. Sparger ring made of 3 inch 316L SS pipe with 21.5 inch sides and located 6 inches from tank bottom. Oxidation tank diameter is 8 ft. Tank slurry level was 18 ft.
Absorbent	Lime slaked to 20 wt% slurry with makeup water and added to venturi downcomer and spray tower hold tank.	Lime slaked to 20 wt% slurry with makeup water and added to venturi downcomer and spray tower hold tank.	Lime slaked to 20 wt% slurry with makeup water and added to venturi downcomer and spray tower hold tank.	Lime slaked to 20 wt% slurry with makeup water and added to venturi downcomer and spray tower hold tank.
Scrubber Internals	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.
System Changes Before Start of Run	No cleaning. Radial flow agitator was changed to axial flow agitator in the oxidation tank. The air sparger was changed from 130 1/8 in. holes to 40 1/4 in. holes. The flue gas was changed from with-fly-ash to fly-ash-free.	(No shutdown.)	No cleaning. One-half of the vacuum filter cloth was blanked off with adhesive so the filter could be operated continuously.	No cleaning. No changes.
Method of Control	Venturi inlet pH controlled at 4.5 ± 0.2 and spray tower inlet pH at 8.0 ± 0.2 by separate lime additions. Venturi recirculated slurry solids controlled at 15 ± 1%. Clarified liquor to be returned to spray tower EHT.	Venturi inlet pH controlled at 5.0 ± 0.2 and spray tower inlet pH at 8.0 ± 0.2 by separate lime additions. Venturi recirculated slurry solids controlled at 15 ± 1%. Clarified liquor returned to spray tower EHT.	Venturi inlet pH controlled at 5.5 ± 0.2 and spray tower inlet at 8.0 ± 0.2 by separate lime additions. Venturi recirculated slurry solids controlled at 15 ± 1%. Clarified liquor returned to spray tower EHT.	Venturi inlet pH controlled at 5.5 ± 0.2 and spray tower inlet pH at 8.0 ± 0.2 by separate lime additions. Venturi recirculated slurry solids controlled at 8 ± 1%. All clarified liquor returned to oxidation tank.
Run Philosophy	First two-stage forced oxidation run with lime scrubbing and fly ash-free flue gas.	To test the effect of a higher venturi inlet pH of 5.0 on sulfite oxidation and sludge characteristics.	To test the effect of a higher venturi inlet pH of 5.5 on sulfite oxidation and sludge characteristics.	To test the effect of lower percent solids (8%) in the oxidation tank on sulfite oxidation and sludge characteristics.
Results	Sulfite oxidation averaged 98% with 81% SO_2 removal and 98% lime utilization. The average solids in the discharge cake was 75%. Vacuum filter had to be operated intermittently due to low solids production rate (no fly ash) and high filtration rate. The scrubber was not shut down at the end of the run.	Sulfite oxidation averaged 97% with 88% SO_2 removal and 98% lime utilization. Average solids in the discharge cake was 83%. The vacuum filter was operated intermittently. The mist eliminator was 0.5% restricted at the end of the run.	Sulfite oxidation averaged 97% with 84% SO_2 removal and 99% lime utilization. Average solids in the discharge cake was 78%. The mist eliminator was 0.5% restricted at the end of the run.	Sulfite oxidation averaged 97% with 83% SO_2 removal and 98% lime utilization. Average solids in the discharge cake was 81%. Filter cloth was blinded and replaced 7/19/77. The mist eliminator was 0.5% restricted at the end of the run.

Table E-4 (continued)

SUMMARY OF FORCED-OXIDATION LIME TESTS ON THE TWO-LOOP VENTURI/SPRAY TOWER SYSTEM

Run Number	859-1A	859-1B	859-1C	859-1D
Start-of-Run Date	7/20/77	7/25/77	7/28/77	8/2/77
End-of-Run Date	7/25/77	7/28/77	8/2/77	8/5/77
On Stream Hours	115	70	120	72
Fly Ash	No	No	No	No
MgO Addition	No	No	No	No
Gas Rate, acfm @ 300°F	25,000	25,000	25,000	25,000
Spray Tower Gas Vel., ft/sec @ 125°F	6.7	6.7	6.7	6.7
Venturi Liquor Rate, gpm	600	600	600	600
Venturi L/G, gal/Mcf	30	30	30	30
Spray Tower Liquor Rate, gpm	1400	1400	1400	1400
Spray Tower L/G, gal/Mcf	70	70	70	70
Venturi Percent Solids Recirculated	12.6 - 15.6	13.7 - 15.3	14.0 - 16.2	14.1 - 14.6
Spray Tower Percent Solids Recirculated	6.8 - 7.6	7.3 - 7.8	6.9 - 7.7	6.6 - 7.5
Venturi Oxidation Tank Residence Time, min.	11.3	11.3	11.3	11.3
Venturi Desupersaturation Tank Residence Time, min.	4.7	4.7	4.7	4.7
Spray Tower Effluent Residence Time, min.	18	18	18	18
Solids Disposal System	Clarifier & Filter	Clarifier & Filter	Clarifier & Filter	Clarifier & Filter
Stoichiometric Ratio in Venturi Inlet Slurry, moles Ca/mole SO_2	1.01 - 1.06	1.00 - 1.03	1.02 - 1.07	1.08 - 1.14
Stoichiometric Ratio in Spray Tower Inlet Slurry, moles Ca/mole SO_2	1.13 - 1.18	1.12 - 1.19	1.13 - 1.17	1.15 - 1.19
Overall Avg. % Lime Utilization, 100 x moles SO_2 abs./mole Ca added	97	99	96	90
Inlet O_2 Concentration, vol. %	7.0 - 8.6	9.7 - 10.8	8.0 - 10.0	7.0 - 9.0
Inlet SO_2 Concentration, ppm	2700 - 3200	2400 - 3000	2300 - 3100	2200 - 3000
Overall Percent SO_2 Removal	88 - 96	89 - 95	86 - 97	88 - 97
Average SO_2 Make-per-pass, m-mole/l	7.3	6.7	6.4	6.4
Venturi Inlet pH Range	5.4 - 5.6	5.4 - 5.7	5.3 - 5.7	5.3 - 5.6
Venturi Outlet pH Range	4.3 - 4.8	3.7 - 4.6	4.4 - 4.7	4.4 - 4.8
Spray Tower Inlet pH Range	8.0 - 8.2	7.9 - 8.2	7.8 - 8.2	7.9 - 8.1
Spray Tower Outlet pH Range	--	--	--	--
Percent Sulfite Oxidized in Venturi Inlet Slurry	68 - 84	97 - 100	58 - 79	22 - 38
Percent Sulfite Oxidized in Spray Tower Inlet Slurry	2 - 18	6 - 18	14 - 26	3 - 17
Air Flow Rate to Oxidizer, acfm	135	150	100	0
Avg. Air Stoichiometric Ratio lb-atoms oxygen/lb-mole SO_2 absorbed	1.20	1.50	1.0	0
Solids in Sludge Discharged, %	64 - 83	69 - 86	64 - 77	52 - 57
Calculated Avg. % Gypsum Saturation in Venturi Inlet Liquor @ 50°C	95	105	105	115
Calculated Avg. % Gypsum Saturation in Spray Tower Inlet Liquor @ 50°C	60	90	90	50
Total Dissolved Solids in Venturi Inlet Liquor, ppm	9500 - 9900	9400 - 10,000	9100 - 11,100	10,000 - 10,500
Total Dissolved Solids in Spray Tower Inlet Liquor, ppm	5600 - 6700	6100 - 7000	6400 - 6900	5200 - 6200
Total ΔP Range, Excluding Mist Elimination System, in. H_2O	11.5 - 12.0	11.5 - 12.9	11.6 - 12.4	11.5 - 12.0
Venturi ΔP (nominal), in. H_2O	9	9	9	9
Mist Elimination System ΔP Range, in. H_2O	0.30 - 0.34	0.28 - 0.32	0.30 - 0.31	0.30 - 0.32
Mist Elimination System Configuration	3-pass, open-vane, 316L SS chevron mist eliminator.	3-pass, open-vane, 316L SS chevron mist eliminator.	3-pass, open-vane, 316L SS chevron mist eliminator.	3-pass, open-vane, 316L SS chevron mist eliminator.
Mist Eliminator Wash Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on 4 min. (at 0.53 gpm/sq. ft.) with 76 min. off between nozzles. Bottom washed intermittently with makeup water through 10 nozzles at 1.5 gpm/sq. ft. for 6 min. every 4 hours.	Top washed sequentially with makeup water. Each nozzle (6 total) on 4 min. (at 0.53 gpm/sq. ft.) with 76 min. off between nozzles. Bottom washed intermittently with makeup water through 10 nozzles at 1.5 gpm/sq. ft. for 6 min. every 4 hours.	Top washed sequentially with makeup water. Each nozzle (6 total) on 4 min. (at 0.53 gpm/sq. ft.) with 76 min. off between nozzles. Bottom washed intermittently with makeup water through 10 nozzles at 1.5 gpm/sq. ft. for 6 min. every 4 hours.	Top washed sequentially with makeup water. Each nozzle (6 total) on 4 min. (at 0.53 gpm/sq. ft.) with 76 min. off between nozzles. Bottom washed intermittently with makeup water through 10 nozzles at 1.5 gpm/sq. ft. for 6 min. every 4 hours.

Table E-4 (continued)

SUMMARY OF FORCED-OXIDATION LIME TESTS ON THE TWO-LOOP VENTURI/SPRAY TOWER SYSTEM

Run Number	859-1A	859-1B	859-1C	859-1D
Oxidizer Design	Octagonal sparger ring with 40 1/4 inch diameter holes on bottom side. Sparger ring made of 3 inch 316L SS pipe with 21.5 inch sides and located 6 inches from tank bottom. Oxidation tank diameter is 8 ft. Tank slurry level was 18 ft.	Octagonal sparger ring with 40 1/4 inch diameter holes on bottom side. Sparger ring made of 3 inch 316L SS pipe with 21.5 inch sides and located 6 inches from tank bottom. Oxidation tank diameter is 8 ft. Tank slurry level was 18 ft.	Octagonal sparger ring with 40 1/4 inch diameter holes on bottom side. Sparger ring made of 3 inch 316L SS pipe with 21.5 inch sides and located 6 inches from tank bottom. Oxidation tank diameter is 8 ft. Tank slurry level was 18 ft.	Octagonal sparger ring with 40 1/4 inch diameter holes on bottom side. Sparger ring made of 3 inch 316L SS pipe with 21.5 inch sides and located 6 inches from tank bottom. Oxidation tank diameter is 8 ft. Tank slurry level was 18 ft.
Absorbent	Lime slaked to 20 wt% slurry with makeup water and added to venturi downcomer and spray tower hold tank.	Lime slaked to 20 wt% slurry with makeup water and added to venturi downcomer and spray tower hold tank.	Lime slaked to 20 wt% slurry with makeup water and added to venturi downcomer and spray tower hold tank.	Lime slaked to 20 wt% slurry with makeup water and added to venturi downcomer and spray tower hold tank.
Scrubber Internals	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.
System Changes Before Start of Run	No cleaning. No changes	(No shutdown.)	(No shutdown.)	(No shutdown.)
Method of Control	Venturi inlet pH controlled at 5.5 ± 0.2 and spray tower inlet pH at 8.0 ± 0.2 by separate lime additions. Venturi recirculated slurry solids controlled at 15 ± 1%. All clarified liquor returned to spray tower EHT.	Venturi inlet pH controlled at 5.5 ± 0.2 and spray tower inlet pH at 8.0 ± 0.2 by separate lime additions. Venturi recirculated slurry solids controlled at 15 ± 1%. All clarified liquor returned to spray tower EHT.	Venturi inlet pH controlled at 5.5 ± 0.2 and spray tower inlet pH at 8.0 ± 0.2 by separate lime additions. Venturi recirculated slurry solids controlled at 15 ± 1%. All clarified liquor returned to spray tower EHT.	Venturi inlet pH controlled at 5.5 ± 0.2 and spray tower inlet pH at 8.0 ± 0.2 by separate lime additions. Venturi recirculated slurry solids controlled at 15 ± 1%. All clarified liquor returned to spray tower EHT.
Run Philosophy	First of a set of runs (Runs 859-1A through 859-1D) to test the effect of air flow rate to the sparger on sulfite oxidation and to determine the minimum air flow rate necessary for complete oxidation.	Base case for runs with varying air rate. Test conditions identical to Run 857-1A.	To test the effect of 100 scfm air rate on sulfite oxidation.	To determine natural degree of sulfite oxidation (no air flow to the air sparger) of the scrubber system.
Results	At 135 scfm air flow, sulfite oxidation averaged 76% and solids in the filter cake averaged 74%. SO_2 removal averaged 92% and lime utilization averaged 97%. The mist eliminator was not inspected at the end of the run.	At 150 scfm air flow, sulfite oxidation averaged 99% and solids in the filter cake averaged 78%. SO_2 removal averaged 92%. Lime utilization averaged 99%. The mist eliminator was not inspected at the end of the run.	At 100 scfm air flow, sulfite oxidation averaged 69% and solids in the filter cak averaged 71%. SO_2 removal averaged 92%. Lime utilization averaged 96%. The mist eliminator was not inspected at the end of the run	With the air sparger turned off, sulfite oxidation averaged 30%. Solids in the filter cake averaged 55%. SO_2 removal averaged 93%. Lime utilization average 90%. The mist eliminator was clean after 24 hours. It was not inspected at the end of the run.

Table E-4 (continued)

SUMMARY OF FORCED-OXIDATION LIME TESTS ON THE TWO-LOOP VENTURI/SPRAY TOWER SYSTEM

Run Number	860-1A	861-1A	862-1A	863-1A
Start-of-Run Date	8/ 5/77	10/ 6/77	10/11/77	12/16/77
End-of-Run Date	8/11/77	10/11/77	10/18/77	1/20/78
On Stream Hours	133	117	162	279
Fly Ash Loading	Low	Low	High	High
MgO Addition	No	No	No	No
Gas Rate, acfm @ 300°F	25,000	25,000	35,000	18,000 - 35,000
Spray Tower Gas Vel., ft/sec @ 125°F	6.7	6.7	9.4	4.8 - 9.4
Venturi Liquor Rate, gpm	600	600	600	600
Venturi L/G, gal/Mcf	30	30	21	21 - 42
Spray Tower Liquor Rate, gpm	1400	1400	1400	1600
Spray Tower L/G, gal/Mcf	70	70	50	57 - 111
Venturi Percent Solids Recirculated	12.4 - 16.5	13.4 - 14.9	14.3 - 15.6	13.3 - 17.7
Spray Tower Percent Solids Recirculated	6.3 - 7.7	7.0 - 7.5	15.5 - 19.1	8.9 - 11.9
Venturi Oxidation Tank Residence Time, min.	11.3	11.3	11.3	11.3
Venturi Desupersaturation Tank Residence Time, min.	4.7	4.7	4.7	4.7
Spray Tower Effluent Residence Time, min.	12.6	18	18	14.7
Solids Disposal System	Clarifier & Filter	Clarifier & Filter	Clarifier & Filter	Clarifier & Filter
Stoichiometric Ratio in Venturi Inlet Slurry, moles Ca/mole SO_2	1.00 - 1.02	1.00 - 1.02	1.00 - 1.05	1.00 - 1.05
Stoichiometric Ratio in Spray Tower Inlet Slurry, moles Ca/mole SO_2	1.16 - 1.20	1.12 - 1.20	1.09 - 1.13	1.04 - 1.18
Overall Avg. % Lime Utilization, 100 x moles SO_2 abs. /mole Ca added	99	99	98	98
Inlet O_2 Concentration, vol. %	7.7 - 8.5	8.0 - 9.3	6.1 - 9.1	7.2 - 11.5
Inlet SO_2 Concentration, ppm	1900 - 2500	2200 - 3200	2200 - 3100	2300 - 3600
Overall Percent SO_2 Removal	92 - 98	86 - 97	78 - 92	77 - 99
Average SO_2 Make-Per-Pass, m-mole/l	5.5	6.6	8.3	4 - 10
Venturi Inlet pH Range	5.3 - 5.7	5.2 - 5.8	5.3 - 5.7	5.2 - 6.0
Venturi Outlet pH Range	3.4 - 4.1	3.0 - 3.5	4.0 - 4.6	3.8 - 4.9
Spray Tower Inlet pH Range	7.9 - 8.1	7.7 - 8.2	7.8 - 8.2	7.5 - 8.1
Spray Tower Outlet pH Range	--	5.5 - 6.2	5.2 - 6.4	4.9 - 5.7
Percent Sulfite Oxidized in Venturi Inlet Slurry	97 - 100	97 - 99	95 - 99	93 - 100
Percent Sulfite Oxidized in Spray Tower Inlet Slurry	5 - 15	13 - 25	14 - 22	10 - 32
Air Flow Rate to Oxidizer, acfm	150	150	210	210
Avg. Air Stoichiometric Ratio, lb-atoms oxygen/lb-mole SO_2 absorbed	1.75	1.50	1.65	1.40 - 2.75
Solids in Sludge Discharged, %	74 - 89	82 - 90	82 - 89	80 - 89
Calculated Avg. % Gypsum Saturation in Venturi Inlet Liquor @ 50°C	100	95	105	105
Calculated Avg. % Gypsum Saturation in Spray Tower Inlet Liquor @ 50°C	70	90	85	100
Total Dissolved Solids in Venturi Inlet Liquor, ppm	10,700 - 14,400	14,400 - 16,000	15,100 - 18,500	17,200 - 19,800
Total Dissolved Solids in Spray Tower Inlet Liquor, ppm	5900 - 7300	8,600 - 10,400	6,200 - 8,400	10,200 - 12,600
Total ΔP Range, Excluding Mist Elimination System, in. H_2O	11.5 - 12.2	10.9 - 13.5	14.5 - 16.2	4.9 - 16.2
Venturi ΔP (nominal), in. H_2O	9	9	9	2.2 - 8.9
Mist Elimination System ΔP Range, in. H_2O	0.30 - 0.33	0.27 - 0.32	0.55 - 0.64	0.06 - 0.61
Mist Elimination System Configuration	3-pass, open-vane, 316L SS chevron mist eliminator.	3-pass, open-vane, 316L SS chevron mist eliminator.	3-pass, open-vane, 316L SS chevron mist eliminator.	3-pass, open-vane, 316L SS chevron mist eliminator.
Mist Eliminator Wash Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on 4 min. (at 0.53 gpm/sq. ft.) with 76 min. off between nozzles. Bottom washed intermittently with makeup water through 10 nozzles at 1.5 gpm/sq. ft. for 6 min. every 4 hours.	Top washed sequentially with makeup water. Each nozzle (6 total) on 4 min. (at 0.53 gpm/sq. ft.) with 76 min. off between nozzles. Bottom washed intermittently with makeup water through 10 nozzles at 1.5 gpm/sq. ft. for 6 min. every 4 hours.	Top washed sequentially with makeup water. Each nozzle (6 total) on 4 min. (at 0.53 gpm/sq. ft.) with 76 min. off between nozzles. Bottom washed intermittently with makeup water through 10 nozzles at 1.5 gpm/sq. ft. for 6 min. every 4 hours.	Top washed sequentially with makeup water. Each nozzle (6 total) on 4 min. (at 0.53 gpm/sq. ft.) with 76 min. off between nozzles. Bottom washed intermittently using 10 nozzles with makeup water. The nozzles are on 6 min. every 4 hours (at 1.5 gpm/sq. ft.)

Table E-4 (continued)

SUMMARY OF FORCED-OXIDATION LIME TESTS ON THE TWO-LOOP VENTURI/SPRAY TOWER SYSTEM

Run Number	860-1A	861-1A	862-1A	863-1A
Oxidizer Design	Octagonal sparger ring with 40 1/4 inch diameter holes on bottom side. Sparger ring made of 3 inch 316L SS pipe with 21.5 inch sides and located 6 inches from tank bottom. Oxidation tank diameter is 8 ft. Tank slurry level was 18 ft.	A single 3 inch diameter 316L SS pipe which extends to the center of the oxidation tank and discharges air downward through an open elbow 3 inches from bottom of tank. Oxidation tank diameter is 8 ft. Tank slurry level was 18 ft.	A single 3 inch diameter 316L SS pipe which extends to the center of the oxidation tank and discharges air downward through an open elbow 3 inches from bottom of tank. Oxidation tank diameter is 8 ft. Tank slurry level was 18 ft.	A single 3-inch diameter 316L SS pipe which extends to the center of the oxidation tank and discharges air downward through an open elbow 3 inches from bottom of tank. Oxidation tank diameter is 8 ft. Tank slurry level was 18 ft.
Absorbent	Lime slaked to 20 wt.% slurry with makeup water and added to venturi downcomer and spray tower hold tank.	Lime slaked to 20 wt% slurry with makeup water and added to venturi downcomer and spray tower hold tank.	Lime slaked to 20 wt% slurry with makeup water and added to venturi downcomer and spray tower hold tank.	Lime slaked to 20 wt.% slurry with makeup water and added to venturi downcomer and spray tower hold tank.
Scrubber Internals	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.
System Changes Before Start of Run	(No shutdown.)	Octagonal sparger ring with 40 1/4 inch diameter holes was replaced with single 3 inch diameter pipe that discharges air downward 3 inches from bottom of oxidation tank through an elbow. The areas above the mist eliminator, outlet gas duct to reheater, and trap-out tray were cleaned.	The flue gas was changed from low fly ash loading to high fly ash loading. No cleaning.	Cleaned outlet duct from spray tower to the ID fan, fan damper, trap-out tray, and areas above the mist eliminator. No other changes.
Method of Control	Venturi inlet pH controlled at 5.5 ± 0.2 and spray tower inlet pH at 8.0 ± 0.2 by separate lime additions. Venturi recirculated slurry solids controlled at 15 ± 1%. All clarified liquor returned to spray tower EHT.	Venturi inlet pH controlled at 5.5 ± 0.2 and spray tower inlet pH at 8.0 ± 0.2 by separate lime additions. Venturi recirculated slurry solids controlled at 15 ± 1%. All clarified liquor returned to spray tower EHT.	Venturi inlet pH controlled at 5.5 ± 0.2 and spray tower inlet pH at 8.0 ± 0.2 by separate lime additions. Venturi recirculation slurry solids controlled at 15 ± 1%. All clarified liquor and excess of mist eliminator wash water returned to oxidation tank.	Venturi inlet pH controlled at 5.5 ± 0.2 and spray tower inlet pH at 7.8 ± 0.2 by separate lime addition. Venturi recir. slurry solids cont. at 15 ± 1% and spray tower's at 8-11%. All clar. liquor and excess of ME wash water returned to spray tower EHT and oxid. tank.
Run Philosophy	To test whether spray tower bleed pump cavitation would occur at 7 ft 6 in. spray tower EHT level (12.6 min. residence time). Previous oxidation tests were made at 10 ft 9 in. level. Pump suction point was lowered during April-June 1977 boiler outage. Other test conditions same as Run 859-1B.	To observe whether near complete sulfite oxidation could be achieved with a single 3 inch air pipe (cf. Run 857-1A with an air sparger ring).	To observe whether spray tower could be operated free of sulfite scaling by increasing spray tower slurry solids content. Also, to observe whether near complete sulfite oxidation could be achieved using the 3 inch air pipe at a higher gas rate (35,000 acfm) and higher air flow rate to oxidizer (210 scfm).	This was a one-month reliability test with forced oxidation. Test conditions were selected to meet EPA emission standards (1.2 lb SO_2 and 0.1 lb particulate per 10^6 Btu) and to give reliable scrubber and mist eliminator operation.
Results	Spray tower bleed pump operated without cavitation problem. Overall SO_2 removal averaged 95% and sulfite oxidation averaged 99%. Overall lime utilization averaged 99%. Mist eliminator was 0.5% restricted.	Average sulfite oxidation remained high at 98% (cf. 97% for Run 857-1A) with 99% lime utilization and overall SO_2 removal of 92%. The mist eliminator was 1% restricted at the end of the run.	Sulfite oxidation averaged 97% with 98% lime utilization and and overall SO_2 removal of 85%. The spray tower internals showed a slight gain in white scale at the end of the run, but the scale probe showed cycling scale formation and dissolution throughout the run. The mist eliminator was 1.5% restricted at the end of the run.	Sulfite oxidation averaged 97%. SO_2 removal for entire run averaged 88% at 2950 ppm inlet SO_2, which was higher than the 84% required to meet the emission standard. However, the standard was frequently exceeded for periods greater than the 3 hours allowed by EPA regulations. Average outlet mass loading was 0.046 gr/scf dry (0.034-0.059 range) which was better than 0.052 gr/scf dry (at 30% excess air) required to meet the standard. The mist eliminator was entirely clean at the end of the run.

Table E-4 (continued)

SUMMARY OF FORCED-OXIDATION LIME TESTS ON THE TWO-LOOP VENTURI/SPRAY TOWER SYSTEM

Run Number	864-1A	865-1A	866-1A	867-1A
Start-of-Run Date	1/20/78	1/25/78	2/14/78	2/21/78
End-of-Run Date	1/25/78	2/14/78	2/21/78	2/27/78
On Stream Hours	115	254	159	137
Fly Ash Loading	High	High	High	High
MgO Addition	No	No	No	No
Gas Rate, acfm @ 300°F	35,000	35,000	35,000	35,000
Spray Tower Gas Vel., ft/sec @ 125°F	9.4	9.4	9.4	9.4
Venturi Liquor Rate, gpm	600	600	600	600
Venturi L/G, gal/Mcf	21	21	21	21
Spray Tower Liquor Rate, gpm	1600	1600	1600	1600
Spray Tower L/G, gal/Mcf	57	57	57	57
Venturi Percent Solids Recirculated	15.2 - 16.6	14.0 - 16.8	14.3 - 16.7	13.3 - 15.6
Spray Tower Percent Solids Recirculated	9.1 - 9.9	9.0 - 11.2	8.7 - 11.1	9.8 - 13.8
Venturi Oxidation Tank Residence Time, min.	11.3	6.3	6.3	8.8
Venturi Desupersaturation Tank Residence Time, min.	4.7	4.7	4.7	4.7
Spray Tower Effluent Hold Tank Residence Time, min.	14.7	14.7	14.7	14.7
Solids Disposal System	Clarifier & Filter	Clarifier & Filter	Clarifier & Filter	Clarifier & Filter
Stoichiometric Ratio in Venturi Inlet Slurry, moles Ca/mole SO_2	1.00 - 1.03	1.01 - 1.04	1.01 - 1.03	1.00 - 1.02
Stoichiometric Ratio in Spray Tower Inlet Slurry, moles Ca/mole SO_2	1.11 - 1.15	1.07 - 1.13	1.05 - 1.25	1.10 - 1.14
Overall Avg. % Lime Utilization, 100 x moles SO_2 abs./mole Ca added	99	98	98	99
Inlet O_2 Concentration, vol. %	--	--	5.0 - 8.4	8.5 - 9.5
Inlet SO_2 Concentration, ppm	1800 - 2700	1500 - 3100	1100 - 3300	1400 - 3200
Overall Percent SO_2 Removal	89 - 99	79 - 99	89 - 99	80 - 98
Average SO_2 Make-Per-Pass, m-mole/l	7.0	6.8	7.0	6.5
Venturi Inlet pH Range	5.35 - 5.75	5.3 - 5.9	5.1 - 5.9	5.3 - 5.8
Venturi Outlet pH Range	3.9 - 4.5	4.3 - 4.7	4.1 - 4.9	4.05 - 4.7
Spray Tower Inlet pH Range	7.5 - 8.1	7.4 - 8.1	7.4 - 8.1	7.5 - 8.1
Spray Tower Outlet pH Range	--	--	--	--
Percent Sulfite Oxidized in Venturi Inlet Slurry	97 - 99	80 - 98	81 - 99	97 - 99
Percent Sulfite Oxidized in Spray Tower Inlet Slurry	18 - 30	18 - 34	20 - 31	1[illegible] - 23
Air Flow Rate to Oxidizer, acfm	210	290/210	350	210
Avg. Air Stoichiometric Ratio, lb-atoms oxygen/lb-mole SO_2 absorbed	1.75	2.10	2.95	1.80
Solids in Sludge Discharged, %	81 - 88	76 - 84	78 - 84	83 - 88
Calculated Avg. % Gypsum Saturation in Venturi Inlet Liquor @ 50°C	100	100	95	90
Calculated Avg. % Gypsum Saturation in Spray Tower Inlet Liquor @ 50°C	100	95	90	85
Total Dissolved Solids in Venturi Inlet Liquor, ppm	18,900 - 20,300	14,200 - 15,900	14,100 - 15,900	12,900 - 14,100
Total Dissolved Solids in Spray Tower Inlet Liquor, ppm	11,900 - 12,700	9300 - 10,100	8600 - 9800	7400 - 8600
Total ΔP Range, Excluding Mist Elimination System, in. H_2O	13.9 - 16.7	13.8 - 16.2	15.3 - 17.6	15.4 - 17.2
Venturi ΔP (nominal), in. H_2O	9.0	9.0	9.0	9.0
Mist Elimination System ΔP Range, in. H_2O	0.48 - 0.68	0.56 - 0.78	0.61 - 0.75	0.66 - 0.82
Mist Elimination System Configuration	3-pass, open-vane, 316L SS chevron mist eliminator.	3-pass, open-vane, 316L SS chevron mist eliminator.	3-pass, open-vane, 316L SS chevron mist eliminator.	3-pass, open-vane 316L SS chevron mist eliminator.
Mist Eliminator Wash Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on 4 min. (at 0.53 gpm/sq. ft.) with 76 min. off between nozzles. Bottom washed intermittently using 10 nozzles with makeup water. The nozzles are on 6 min. every 4 hours (at 1.5 gpm/sq. ft.)	Top washed sequentially with makeup water. Each nozzle (6 total) on 4 min. (at 0.53 gpm/sq. ft.) with 76 min. off between nozzles. Bottom washed intermittently with makeup water through 10 nozzles @ 1.5 gpm/sq. ft. for 6 minutes every 4 hours.	Top washed sequentially with makeup water. Each nozzle (6 total) on 4 min. (at 0.53 gpm/sq. ft.) with 76 min. off between nozzles. Bottom washed intermittently with makeup water through 10 nozzles @ 1.5 gpm/sq. ft. for 6 minutes every 4 hours.	Top washed sequentially with makeup water. Each nozzle (6 total) on 4 min. (at 0.53 gpm/sq/ft.) with 76 min. off between nozzles. Bottom washed intermittently with makeup water through 10 nozzles @ 1.5 gpm/sq. ft. for 6 minutes every 4 hours.

Table E-4 (continued)

SUMMARY OF FORCED-OXIDATION LIME TESTS ON THE TWO-LOOP VENTURI/SPRAY TOWER SYSTEM

Run Number	864-1A	865-1A	866-1A	867-1A
Oxidizer Design	A single 3-inch diameter 316L SS pipe which extends to the center of the oxidation tank and discharges air downward through an open elbow 3 inches from bottom of tank. Oxidation tank diameter is 8 ft. Tank slurry level was 18 ft.	A single 3-inch diameter 316L SS pipe which extends to the center of the oxidation tank and discharges air downward through an open elbow 3 inches from bottom of tank. Oxidation tank diameter is 8 ft. Tank slurry level was 10 ft.	A single 3-inch diameter 316L SS pipe which extends to the center of the oxidation tank and discharges air downward through an open elbow 3 inches from bottom of tank. Oxidation tank diameter is 8 ft. Tank slurry level was 10 ft.	A single 3-inch diameter 316L SS pipe which extends to the center of the oxidation tank, and discharges air downward through an open elbow 3 inches from bottom of tank. Oxidation tank diameter is 8 ft. Tank slurry level was 14 ft.
Absorbent	Lime slaked to 20 wt.% slurry with makeup water and added to venturi downcomer and spray tower hold tank.	Lime slaked to 20 wt% slurry with makeup water and added to venturi downcomer and spray tower hold tank.	Lime slaked to 20 wt% slurry with makeup water and added to venturi downcomer and spray tower hold tank.	Lime slaked to 20 wt% slurry with makeup water and added to venturi downcomer and spray tower hold tank.
Scrubber Internals	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.
System Changes Before Start of Run	No changes. No cleaning.	Oxidation tank overflow lowered to 10 ft from 18 ft. No cleaning.	Spray tower slurry nozzles and headers cleaned. No other changes.	Oxidation tank overflow raised to 14 ft from 10 ft. Spray tower slurry nozzles cleaned.
Method of Control	Venturi inlet pH controlled at 5.5 ± 0.2 and spray tower inlet pH at 7.8 ± 0.2 by separate lime addition. Venturi recir. slurry solids cont. at 15 ± 1% and spray tower's at 8-11%. All clar. liquor and excess of ME wash water returned to spray tower EHT and oxid. tank.	Venturi inlet pH controlled at 5.5 ± 0.2 and spray tower inlet pH at 7.8 ± 0.2 by separate lime additions. Venturi recir. slurry solids cont. at 15 ± 1% and spray tower's at 8-11%. All clar. liquor and excess of ME wash water returned to spray tower EHT and oxid. tank.	Venturi inlet pH controlled at 5.5 ± 0.2 and spray tower inlet pH at 7.8 ± 0.2 by separate lime additions. Venturi recir. slurry solids cont. at 15 ± 1% and spray tower's at 8-11%. All clar. liquor and excess of ME wash water returned to spray tower EHT and oxid. tank.	Venturi inlet pH controlled at 5.5 ± 0.2 and spray tower inlet pH at 7.8 ± 0.2 by separate lime additions. Venturi recir. slurry solids cont. at 15 ± 1% and spray tower's at 8-11%. All clar. liquor and excess of ME wash water returned to spray tower EHT and oxid. tank.
Run Philosophy	This was a base case lime run with 18 ft oxidation tank level for comparison with the succeeding runs, in which the oxidation tank level was dropped to as low as 10 ft to observe the effect on sulfite oxidation.	To observe whether good sulfite oxidation could be achieved with 10 ft slurry level in the oxidation tank. Other test conditions are the same as Run 864-1A.	To observe whether near complete sulfite oxidation could be achieved at 10 ft slurry level in the oxidation tank and with an increased air flow rate of 350 scfm.	To observe the effect of higher oxidation tank level (14 ft) and lower air rate (210 scfm) on sulfite oxidation.
Results	Sulfite oxidation averaged 98% at 18 ft oxidation tank level and 1.75 air stoichiometric ratio. Average SO_2 removal was 94% at 2250 ppm average inlet SO_2 concentration. The scrubber was not inspected (no shutdown) at the end of the run.	Sulfite oxidation averaged 89% at 10 ft oxidation tank level and 2.1 air stoichiometric ratio. SO_2 removal for the run averaged 89% at 2300 ppm inlet SO_2 concentration. The mist eliminator was 2% restricted at the end of the run.	Sulfite oxidation averaged 90% at 10 ft oxidation tank level and 2.95 air stoichiometric ratio. SO_2 removal for entire run averaged 94% at 2200 ppm inlet SO_2 concentration. The mist eliminator was 3% restricted at the end of the run.	Sulfite oxidation averaged 98% at 14 ft oxidation tank level and 1.80 air stoichiometric ratio. SO_2 removal for entire run averaged 89% at 2300 ppm inlet SO_2 concentration. The mist eliminator was 3% restricted at the end of the run.

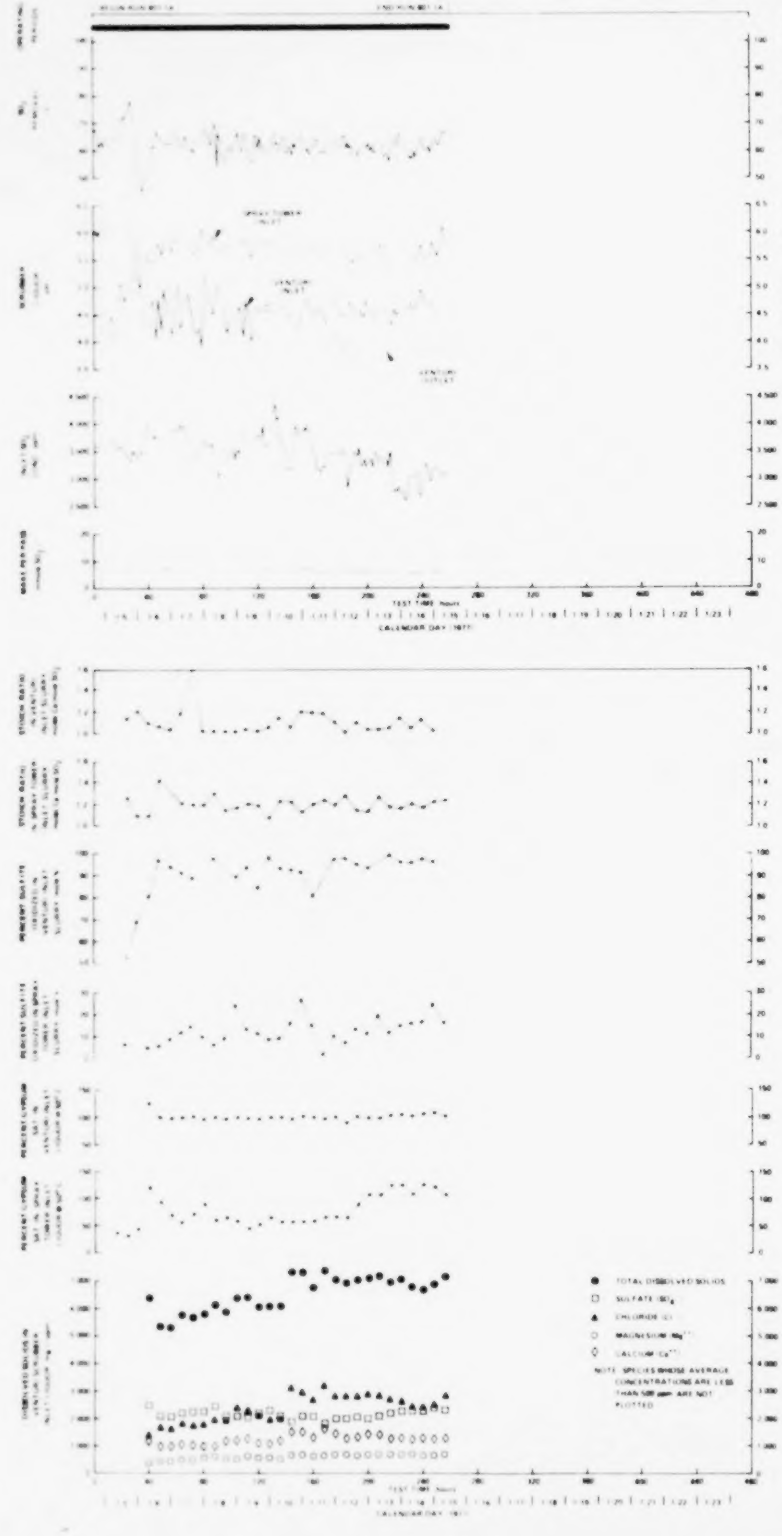
Table E-5

SUMMARY OF FLUE GAS CHARACTERIZATION TESTS WITH LIME ON THE VENTURI/SPRAY TOWER SYSTEM

Run Number	VFG-1P	VFG-1Q	
Start-of-Run Date	11/27/76	6/16/77	
End-of-Run Date	12/4/76	6/23/77	
On Stream Hours	157	78	
Gas Rate, acfm @ 330°F	35,000	35,000	
Spray Tower Gas Vel., fps @125°F	9.4	9.4	
Venturi Liquor Rate, gpm	min. (~140)	0	
Venturi L/G, gal/mcf	5	0	
Spray Tower Liquor Rate, gpm	1400	1400	
Spray Tower L/G, gal/mcf	50	50	
Percent Solids Recirculated	7.5-9.1	14.4 - 15.5	
Effluent Residence Time, min.	12	18	
Solids Disposal System	Clarifier & Filter	Clarifier	
Stoichiometric Ratio, moles Ca added/mole SO_2 absorbed	1.10-1.16	1.10 - 1.15	
Avg % Lime Utilization, 100 x moles SO_2 abs./mole Ca added	88	89	
Inlet SO_2 Concentration, ppm	2600-3800	2200 - 2700	
Percent SO_2 Removal	58-72	61 - 69	
Scrubber Inlet pH Range	7.85-8.15	7.7 - 8.3	
Scrubber Outlet pH Range	4.5-4.85	—	
Inlet O_2 Concentration, vol %	5-7.5	8.5 - 9.2	
Percent Sulfur Oxidized	2-18	1 - 17	
Loop Closure, % Solids Dischg.	55-60	--	
Calculated Avg % Sulfate Saturation in Scrubber Inlet Liquor @ 50°C	55	10	
Total Dissolved Solids, ppm	6900-8000	1000 - 1600	
Total ΔP Range, Excluding Mist Elimination System, in. H_2O	5.7-9.3	6.6 - 7.2	
Venturi ΔP, in. H_2O	1.4-5.7 (Plug 100% open)	2.2 - 2.8 (Plug 100% open)	
Mist Elimination System ΔP Range, in. H_2O	0.35-0.42	0.62 - 0.68	
Mist Elimination System Configuration	3-pass, open-vane, 316L SS chevron mist eliminator	3-pass, open-vane, 316L SS chevron mist eliminator.	
Absorbent	Lime slurried to 20 wt.% with makeup water and added to scrubber downcomer.	Lime slurried to 20 wt% with makeup water and added to EHT.	
Mist Eliminator Washing Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on 4 min. (at 0.5 gpm/ft²) with 76 min. off between nozzles. Bottom washed with makeup water at 1.5 gpm/ft² for 6 min. every 4 hours.	Top washed sequentially with makeup water. Each nozzle (6 total) on 4 min. (at 0.53 gpm/sq. ft.) with 76 min. off between nozzles. Bottom washed intermittently with makeup water at 1.5 gpm/sq. ft. for 6 min. every 4 hours.	
Scrubber Internals	All nozzles on 4 headers sprayed downwards. 7 nozzles/header on top 3 headers. 6 nozzles on bottom header.	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.	
System Changes Before Start of Run	No changes. No cleaning.	No changes. No cleaning after air/slurry testing during April-June 1977 Boiler No. 10 outage.	
Method of Control	Scrubber inlet liquor pH controlled at 8.0 ± 0.2.	Spray tower inlet pH controlled at 8.0 ± 0.2.	
Run Philosophy	To observe the effect of spray tower-only operation (min. venturi slurry flow rate with plug 100% open) on flue gas characteristics at the inlet and outlet of the scrubber (cf. Run VFG-1C).	To determine the particulate removal efficiency of spray tower alone (no slurry flow to venturi) when operating with fly ash-free flue gas.	
Results	SO_2 removal averaged 65%, lime utilization 88%, and inlet SO_2 concentration 3200 ppm. Sulfate saturation averaged 55%. Mist eliminator was entirely clean at the end of the run after a total 1697 hours of operation without cleaning.	Particulate removal averaged 85%. The venturi averaged 2.5 in. H_2O pressure drop and is believed to have significantly affected the particulate removal.	

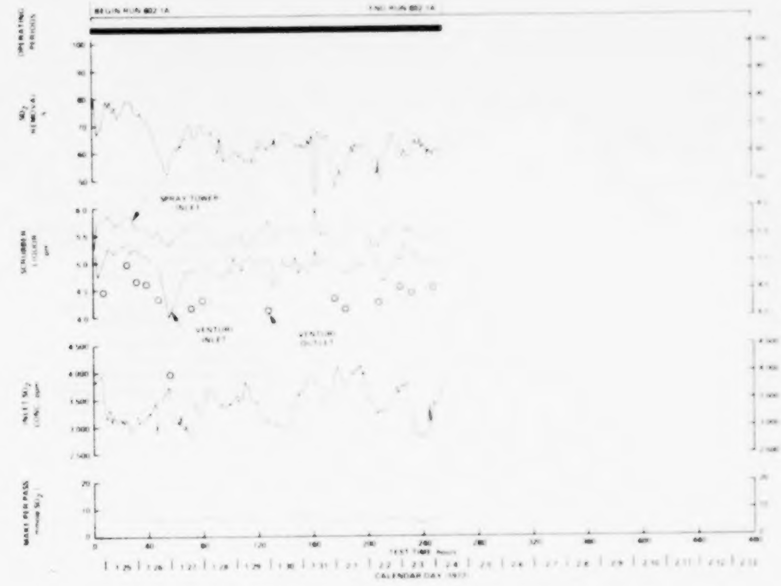
APPENDIX F

GRAPHICAL OPERATING DATA FROM THE VENTURI/SPRAY TOWER TESTS



Gas Rate = 25,000 acfm @ 300° F
Spray Tower Gas Velocity = 6.7 ft/sec
Liquor Rate to Venturi = 400 gpm
Liquor Rate to Spray Tower = 1300 gpm
Venturi L/G = 20 gal/Mcf
Spray Tower L/G = 65 gal/Mcf
No. of Spray Headers = 4
Residence Times
  Spray Tower Hold Tank = 19.4 min
  Oxidation Tank = 17 min
  Desupersaturation Tank = 7 min
Solids Recirculated, Venturi Loop = 12.3-16.8 wt %
Solids Recirculated, Spray Tower Loop = 4.9-6.7 wt %
Venturi Pressure Drop = 9 in. H_2O
Total Pressure Drop, Excl. Mist Elim.
  = 10.6-11.6 in. H_2O
Mist Elim. Pressure Drop = 0.14-0.22 in. H_2O
Air Flow Rate to Oxidizer = 400 scfm
Discharge (Clarifier & Filter) Solids
  Concentration = 76-86 wt %
Limestone Addition to Spray Tower EHT
Clarified Liquor Returned to Spray Tower EHT

Figure F-1. OPERATING DATA FOR VENTURI/SPRAY TOWER RUN 801-1A



Gas Rate = 25,000 acfm @ 300° F
Spray Tower Gas Velocity = 6.7 ft/sec
Liquor Rate to Venturi = 400 gpm
Liquor Rate to Spray Tower = 1400 gpm
Venturi L/G = 20 gal/Mcf
Spray Tower L/G = 70 gal/Mcf
No. of Spray Headers = 4
Residence Times:
Spray Tower Hold Tank = 18 min
Oxidation Tank = 17 min
Desupersaturation Tank = 7 min
Solids Recirculated, Venturi Loop = 12.4-16.8 wt %
Solids Recirculated, Spray Tower Loop = 4.6-7.6 wt %
Venturi Pressure Drop = 9 in. H_2O
Total Pressure Drop, Excl. Mist Elim.
= 10.4-11.2 in. H_2O
Mist Elim. Pressure Drop = 0.20-0.34 in. H_2O
Air Flow Rate to Oxidizer = 400 acfm
Discharge (Clarifier & Filter) Solids
Concentration = 82-90 wt %
Limestone Addition to Spray Tower EHT
Clarified Liquor Returned to Spray Tower EHT

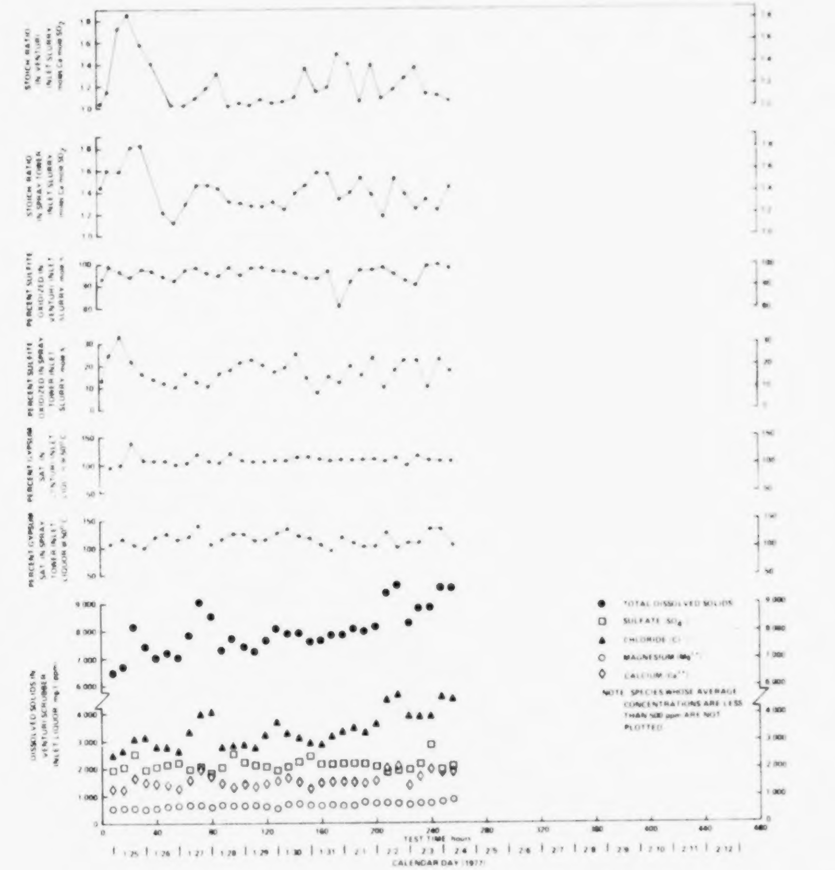
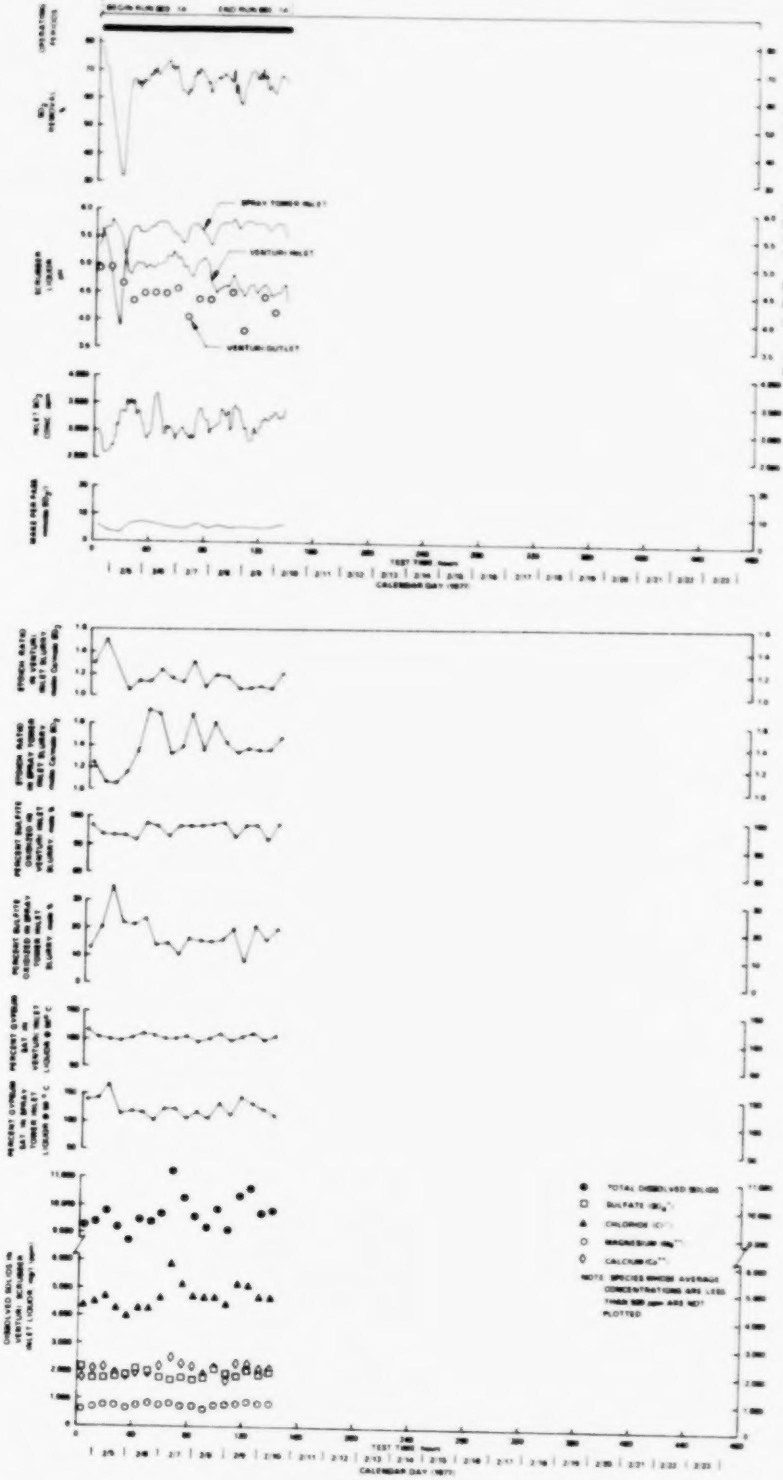
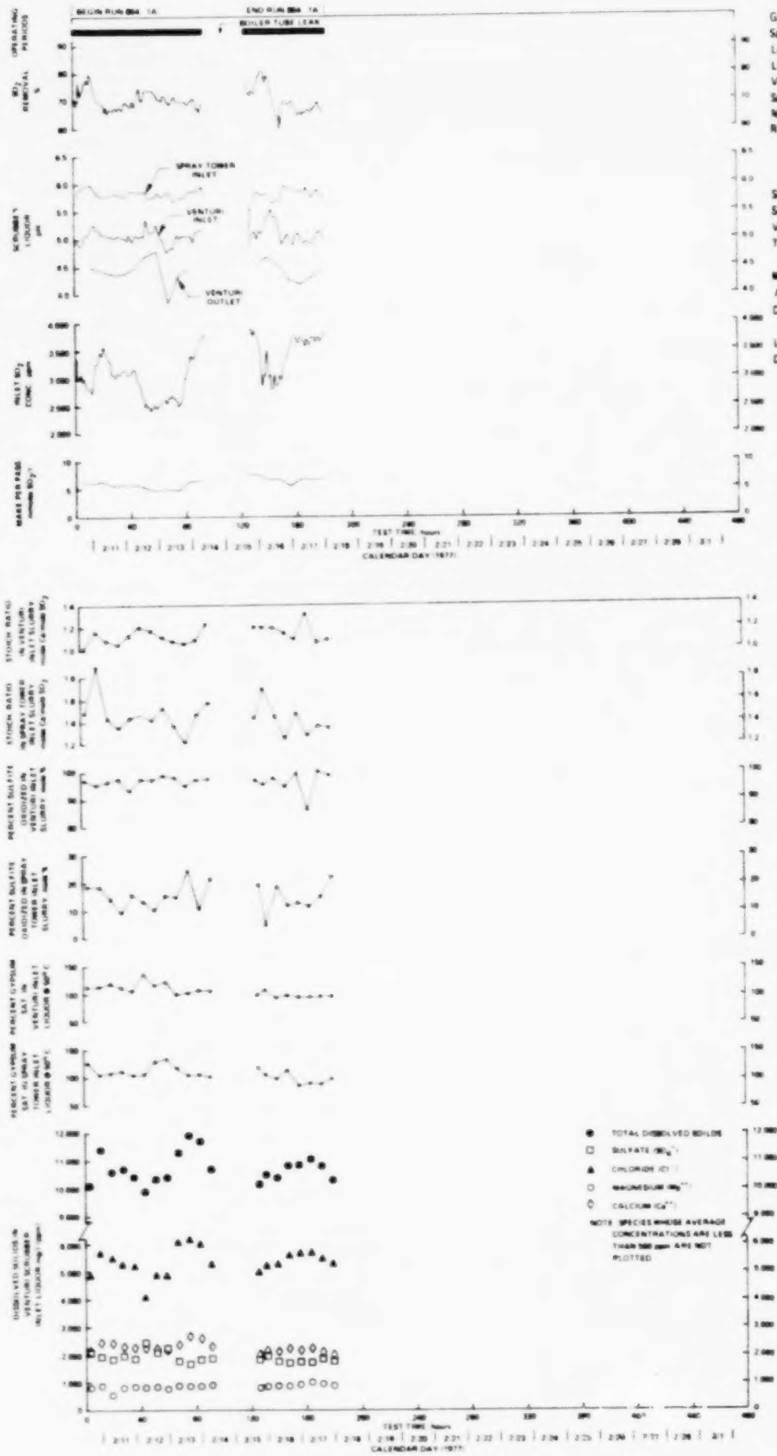


Figure F-2. OPERATING DATA FOR VENTURI/SPRAY TOWER RUN 802-1A



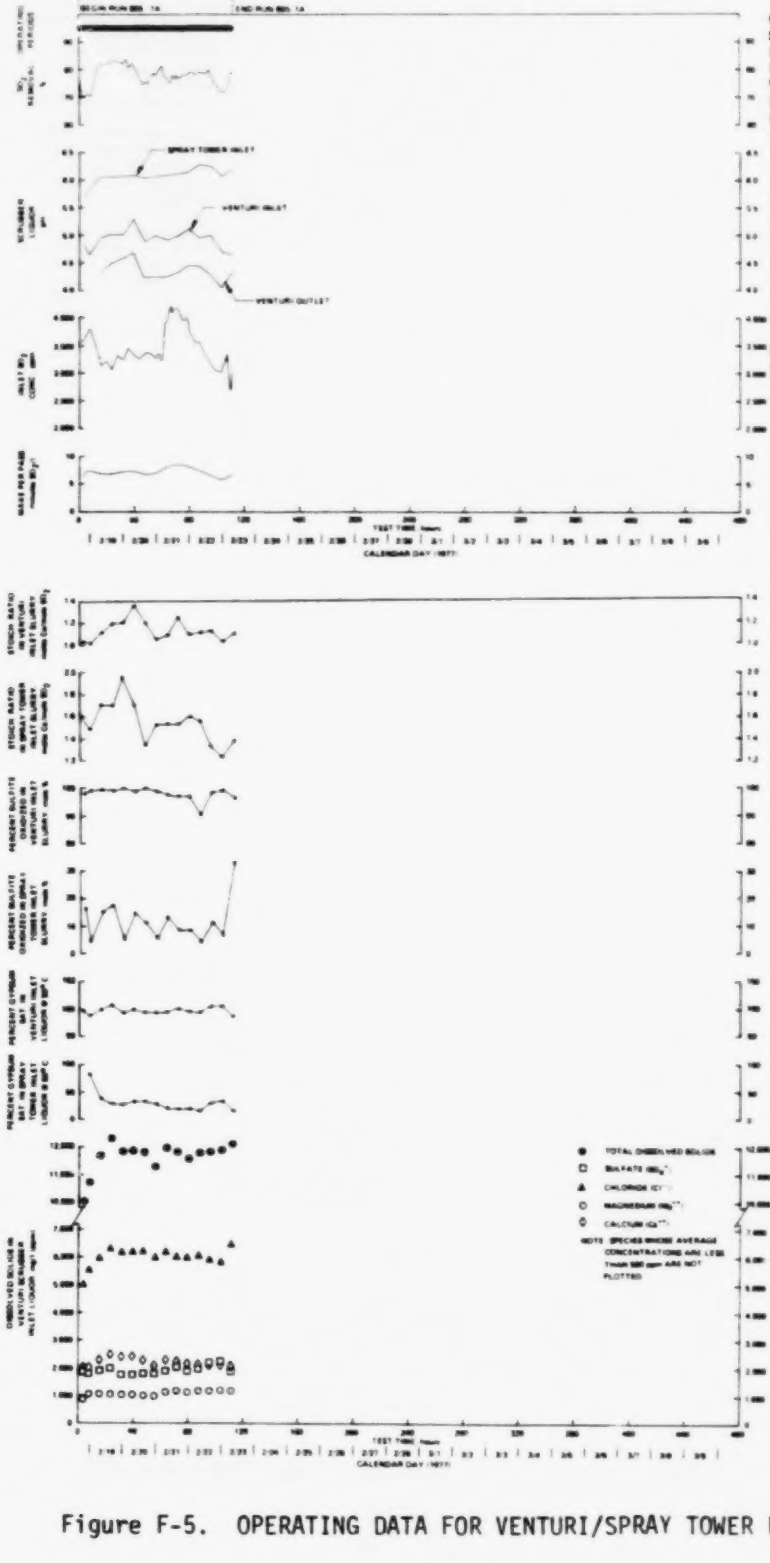
Gas Rate = 25,000 acfm @ 300° F
Spray Tower Gas Velocity = 6.7 ft/sec
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1400 gpm
Venturi L/G = 30 gal/Mcf
Spray Tower L/G = 70 gal/Mcf
No. of Spray Headers = 4
Residence Times
 Spray Tower Hold Tank = 18 min
 Oxidation Tank = 11.3 min
 Desupersaturation tank = 4.7 min
Solids Recirculated, Venturi Loop = 13.4-16.8 wt %
Solids Recirculated, Spray Tower Loop = 4.5-6.3 wt %
Venturi Pressure Drop = 9 in. H_2O
Total Pressure Drop, Excl. Mist Elim.
 = 10.6-11.3 in. H_2O
Mist Elim. Pressure Drop = 0.20-0.30 in. H_2O
Air Flow Rate to Oxidizer = 400 acfm
Discharge (Clarifier & Filter) Solids
 Concentration = 77-85 wt %
Limestone Addition to Spray Tower EHT
Clarified Liquor Returned to Spray Tower EHT

Figure F-3. OPERATING DATA FOR VENTURI/SPRAY TOWER RUN 803-1A



Gas Rate = 25,000 acfm @ 300° F
Spray Tower Gas Velocity = 6.7 ft/sec
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1400 gpm
Venturi L/G = 30 gal/Mcf
Spray Tower L/G = 70 gal/Mcf
No. of Spray Headers = 4
Residence Times
  Spray Tower Hold Tank = 18 min
  Oxidation Tank = 11.3 min
  Desupersaturation Tank = 4.7 min
Solids Recirculated, Venturi Loop = 13.2-16.6 wt %
Solids Recirculated, Spray Tower Loop = 5.9-8.9 wt %
Venturi Pressure Drop = 9 in. H_2O
Total Pressure Drop, Excl. Mist Elim.
  = 9.8-11.2 in. H_2O
Mist Elim. Pressure Drop = 0.18-0.37 in. H_2O
Air Flow Rate to Oxidizer = 400 acfm
Discharge (Clarifier & Filter) Solids
  Concentration = 79-91 wt %
Limestone Addition to Spray Tower EHT
Clarified Liquor Returned to Spray Tower EHT and
  Oxidation Tank

Figure F-4. OPERATING DATA FOR VENTURI/SPRAY TOWER RUN 804-1A



Gas Rate = 25,000 acfm @ 300° F
Spray Tower Gas Velocity = 6.7 ft/sec
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1400 gpm
Venturi L/G = 30 gal/Mcf
Spray Tower L/G = 70 gal/Mcf
No. of Spray Headers = 4
Residence Times:
Spray Tower Hold Tank = 18 min
Oxidation Tank = 11.3 min
Desupersaturation Tank = 4.7 min
Solids Recirculated, Venturi Loop = 13-15.8 wt %
Solids Recirculated, Spray Tower Loop = 13.6-17.8 wt %
Venturi Pressure Drop = 9 in. H_2O
Total Pressure Drop, Excl. Mist Elim.
= 10.1-10.7 in. H_2O
Mist Elim. Pressure Drop = 0.23-1.22 in. H_2O
Air Flow Rate to Oxidizer = 400 acfm
Discharge (Clarifier & Filter) Solids
Concentration = 75-87 wt %
Limestone Addition to Spray Tower EHT
Clarified Liquor Returned to Oxidation Tank

Figure F-5. OPERATING DATA FOR VENTURI/SPRAY TOWER RUN 805-1A

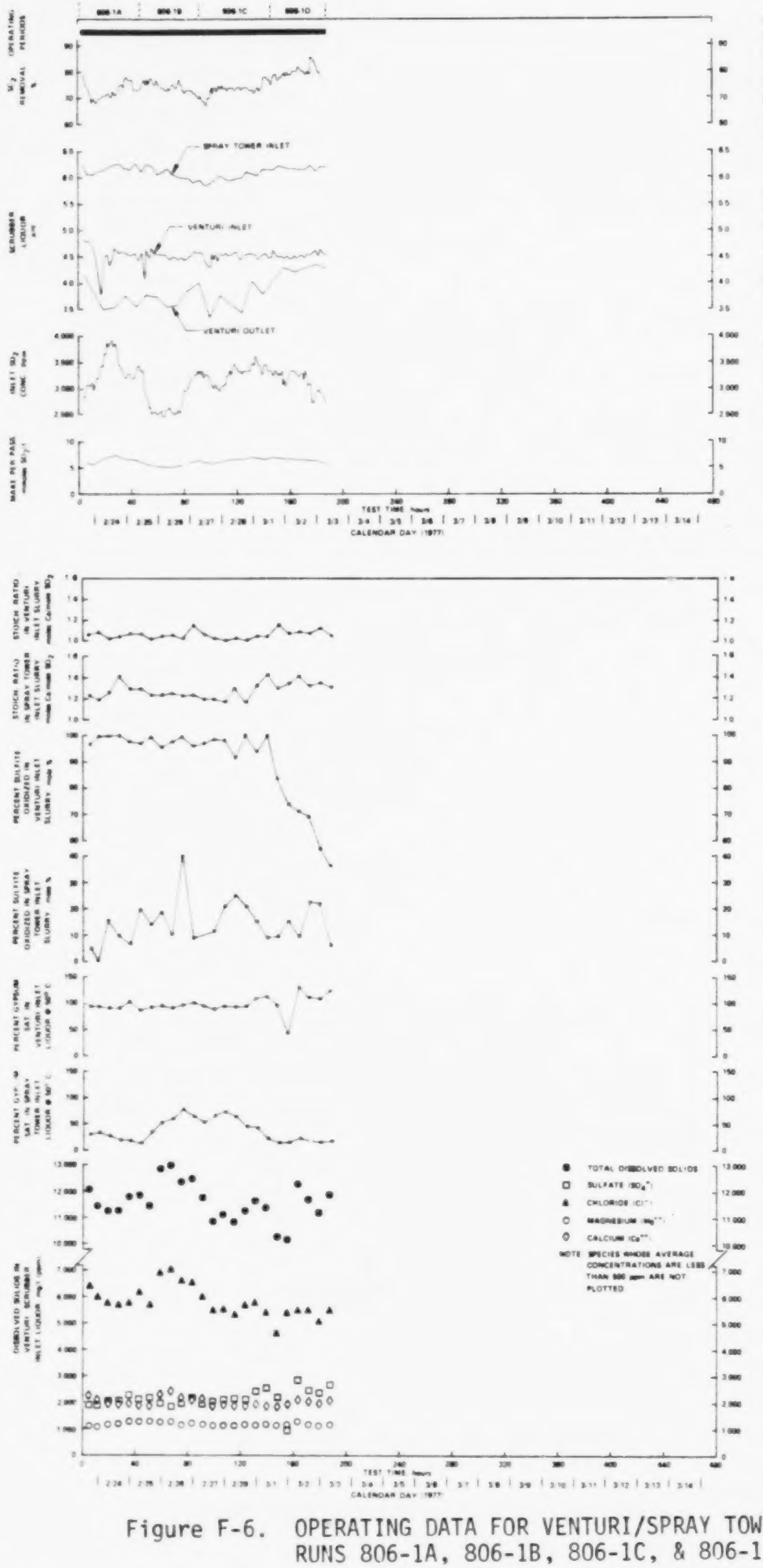
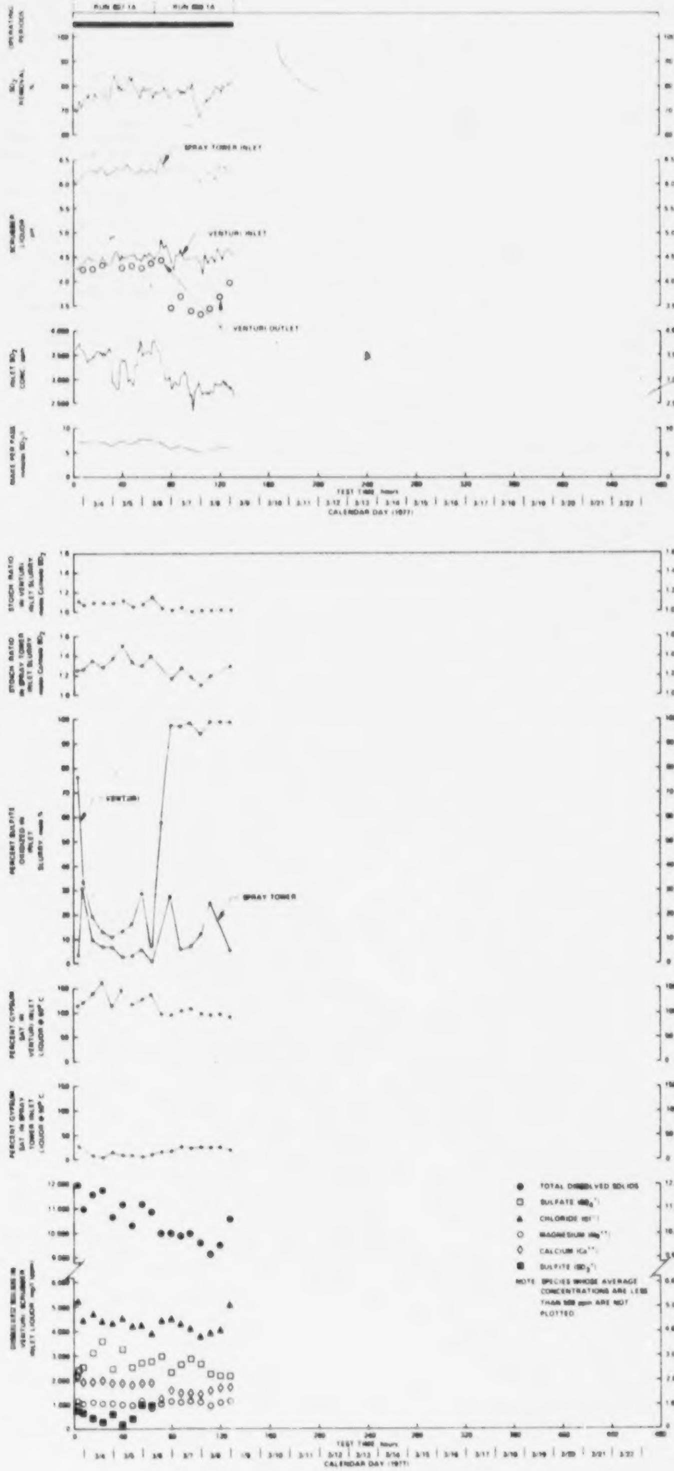


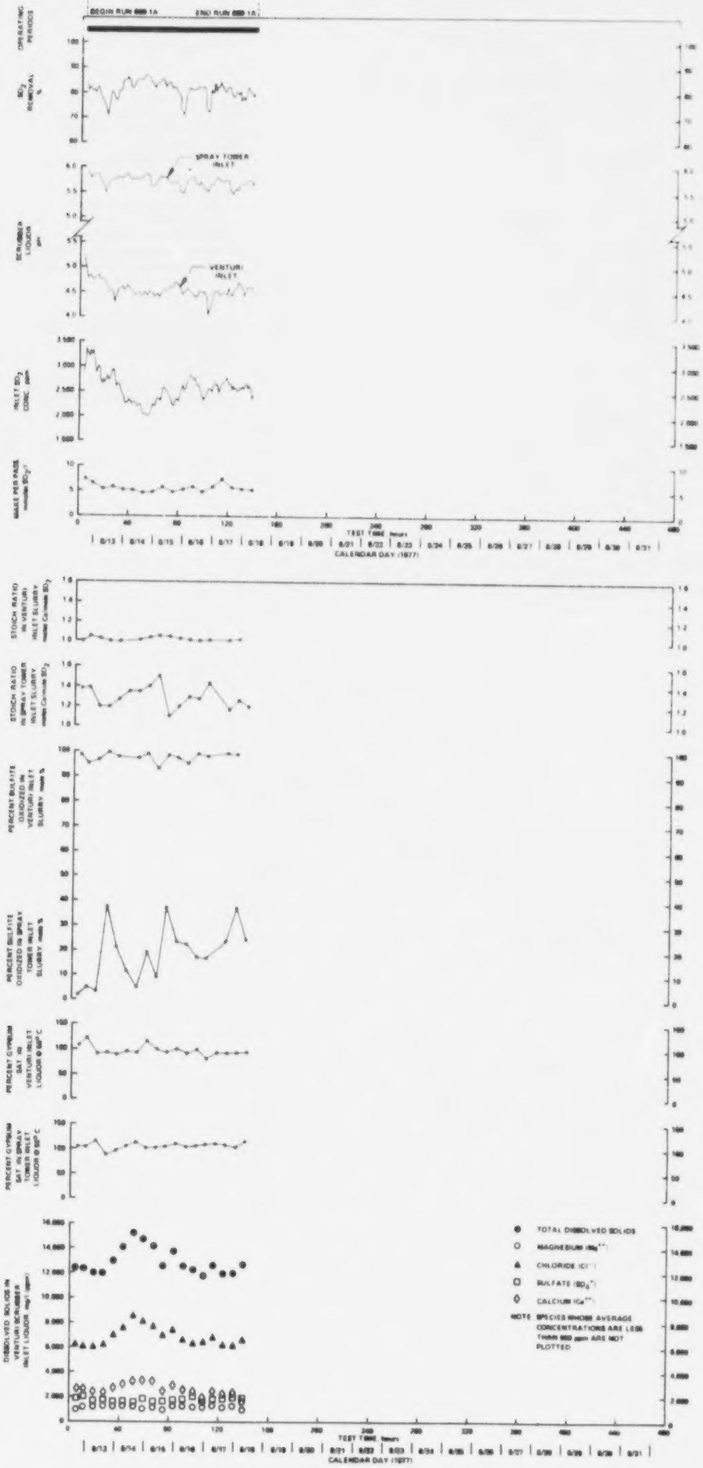
Figure F-6. OPERATING DATA FOR VENTURI/SPRAY TOWER RUNS 806-1A, 806-1B, 806-1C, & 806-1D

Gas Rate = 25,000 acfm @ 300° F
Spray Tower Gas Velocity = 6.7 ft/sec
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1400 gpm
Venturi L/G = 30 gal/Mcf
Spray Tower L/G = 70 gal/Mcf
No. of Spray Headers = 4
Residence Times:
  Spray Tower Hold Tank = 18 min
  Oxidation Tank = 11.3 min
  Desupersaturation Tank = 4.7 min
Solids Recirculated, Venturi Loop = 13.2-16.4 wt %
Solids Recirculated, Spray Tower Loop = 13.3- 16.3 wt %
Venturi Pressure Drop = 9 in. H_2O
Total Pressure Drop, Excl. Mist Elim.
  = 10.4-12.7 in. H_2O
Mist Elim. Pressure Drop = 0.23-0.78 in. H_2O
Air Flow Rate to Oxidizer = 250 scfm (806-1A),
  150 scfm (806-1B), 100 scfm (806-1C),
  50 scfm (806-1D)
Discharge (Clarifier & Filter) Solids
  Concentration = 74-90 wt %
Limestone Addition to Spray Tower EHT
Clarified Liquor Returned to Oxidation Tank



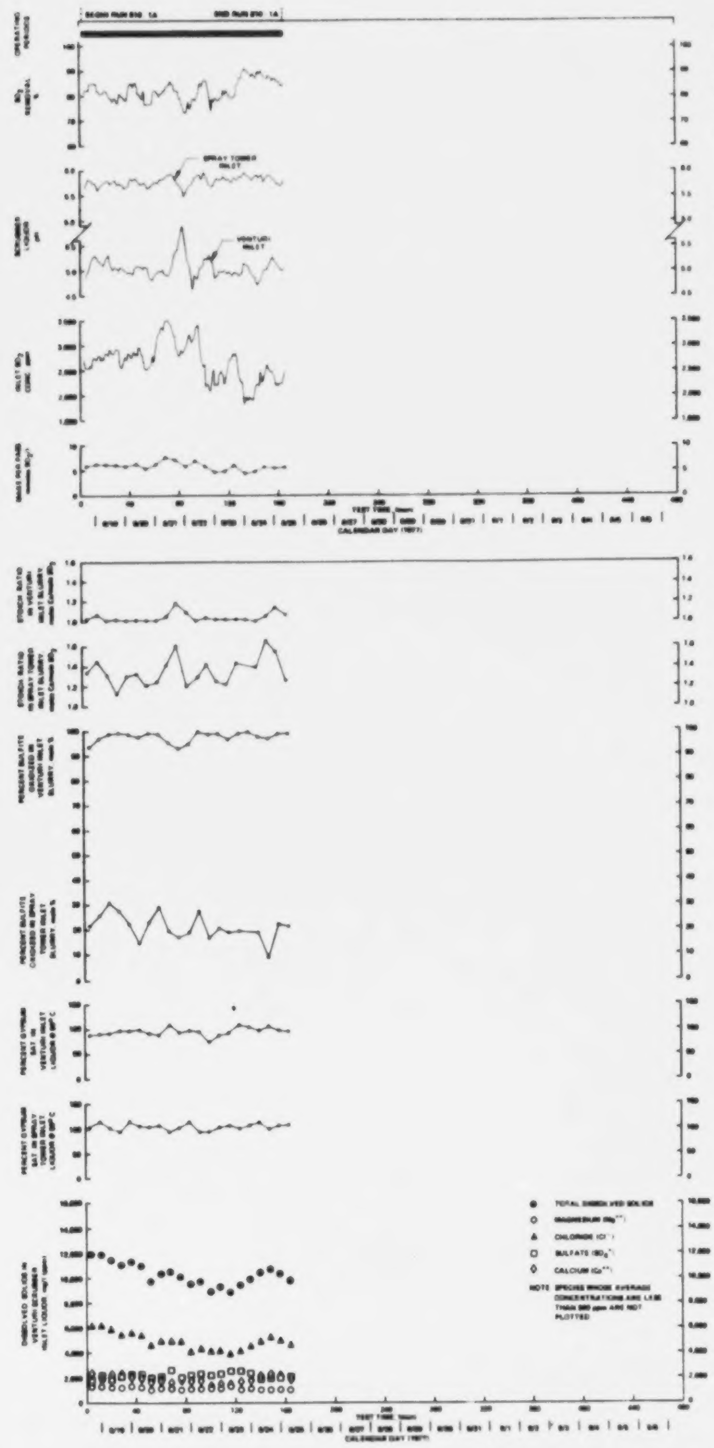
Gas Rate = 25,000 acfm @ 300° F
Spray Tower Gas Velocity = 6.7 ft/sec
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1400 gpm
Venturi L/G = 30 gal/Mcf
Spray Tower L/G = 70 gal/Mcf
No. of Spray Headers = 4
Residence Times
  Spray Tower Hold Tank = 18 min
  Oxidation Tank = 11.3 min
  Desupersaturation Tank = 4.7 min
Solids Recirculated, Venturi Loop = 13.4-15.9 wt %
Solids Recirculated, Spray Tower Loop = 14.8-17.1 wt %
Venturi Pressure Drop = 9 in. H_2O
Total Pressure Drop, Excl. Mist Elim.
  = 10.4-11.1 in. H_2O
Mist Elim. Pressure Drop = 0.26-0.70 in. H_2O
Air Flow Rate to Oxidizer = 0 scfm (807-1A),
  150 scfm (808-1A)
Discharge (Clarifier & Filter) Solids
  Concentration = 66-86 wt %
Limestone Addition to Spray Tower EHT
Clarified Liquor Returned to Oxidation Tank

Figure F-7. OPERATING DATA FOR VENTURI/SPRAY TOWER RUNS 807-1A & 808-1A



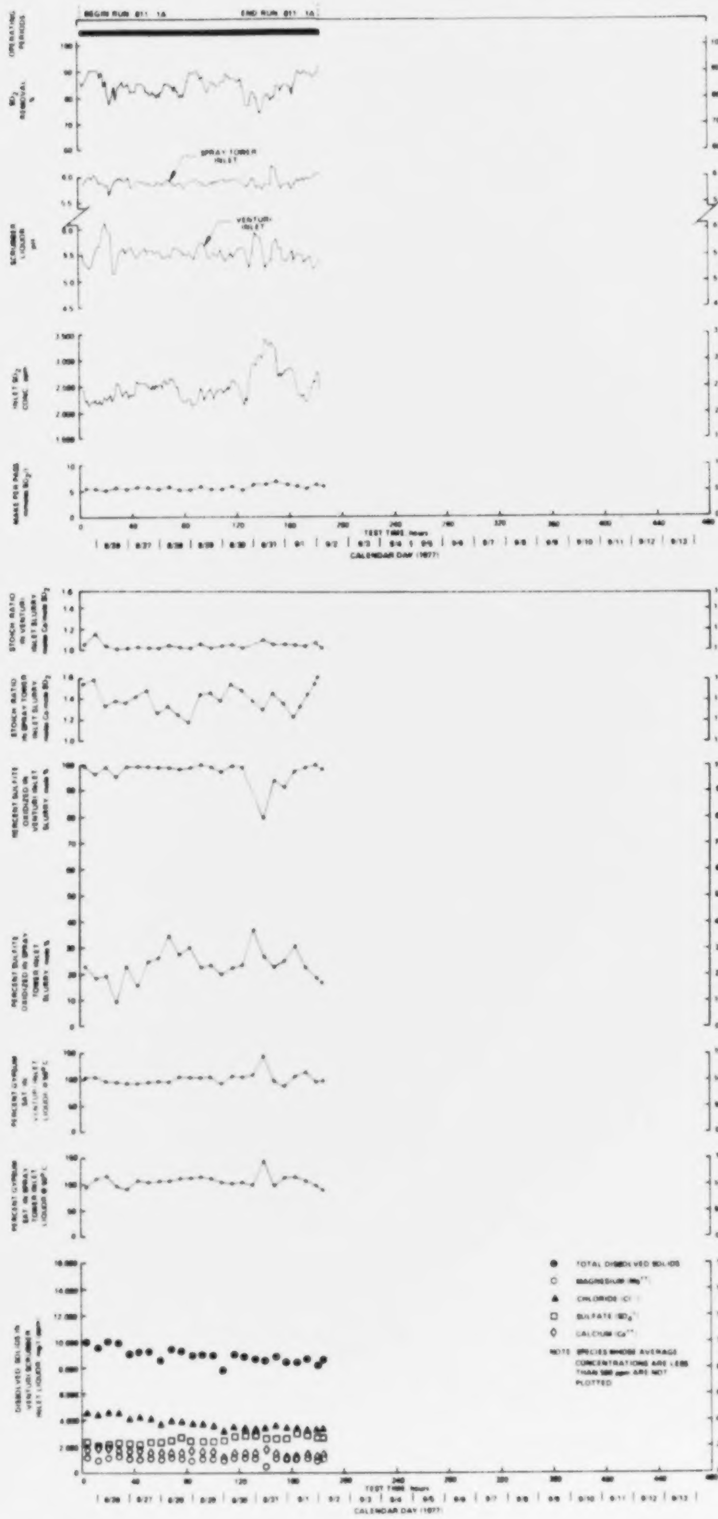
Gas Rate = 25,000 acfm @ 300° F
Spray Tower Gas Velocity = 6.7 ft/sec
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1400 gpm
Venturi L/G = 30 gal/Mcf
Spray Tower L/G = 70 gal/Mcf
No. of Spray Headers = 4
Residence Times
  Spray Tower Hold Tank = 13.4 min
  Oxidation Tank = 11.3 min
  Desupersaturation Tank = 4.7 min
Solids Recirculated, Venturi Loop = 13.5-16.1 wt %
Solids Recirculated, Spray Tower Loop = 7.3-8.4 wt %
Venturi Pressure Drop = 9 in. H_2O
Total Pressure Drop, Excl. Mist Elim.
  = 11.6-12.8 in. H_2O
Mist Elim. Pressure Drop = 0.28-0.36 in. H_2O
Air Flow Rate to Oxidizer = 150 scfm
Discharge (Clarifier & Filter/Lamella Settler) Solids
  Concentration = 72-88/27-43 wt %
Limestone Addition to Spray Tower EHT
Clarified Liquor Returned to Spray Tower EHT

Figure F-8. OPERATING DATA FOR VENTURI/SPRAY TOWER RUN 809-1A



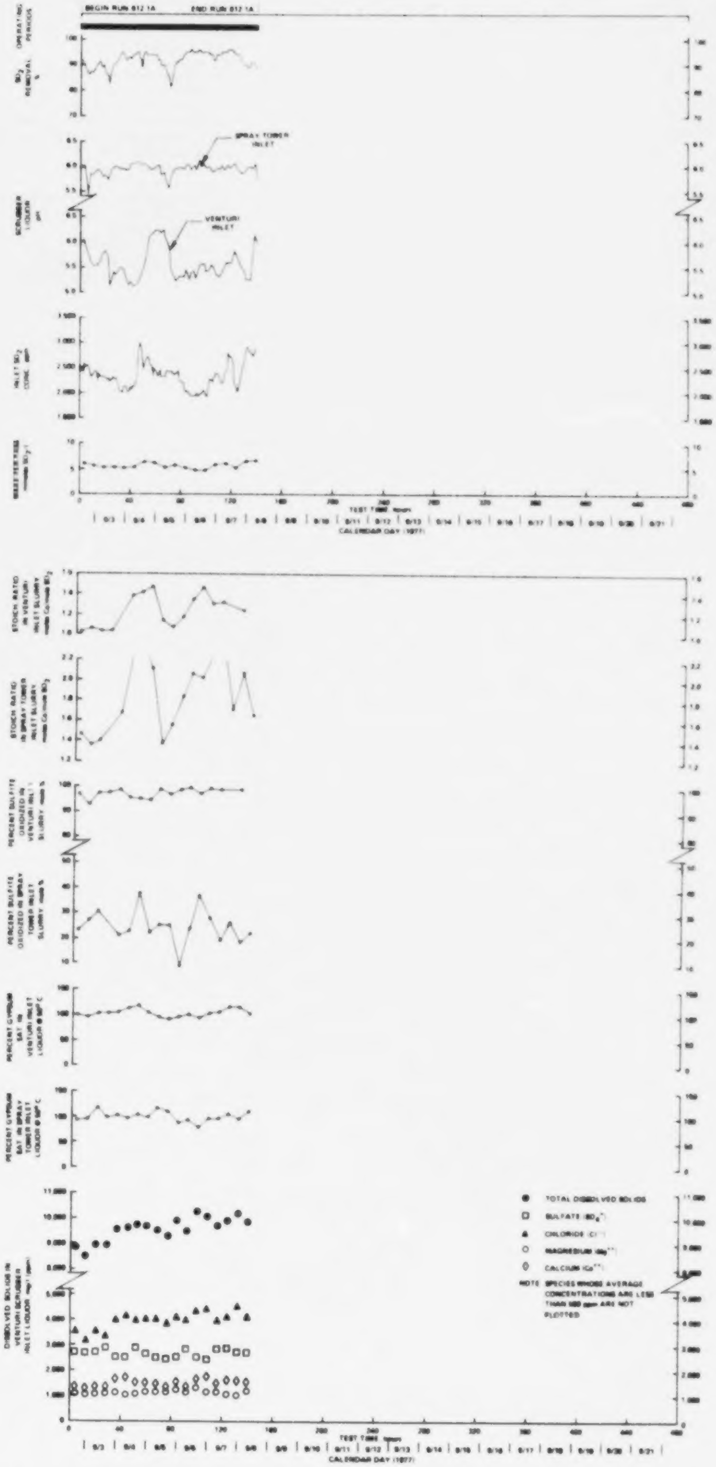
Gas Rate = 35,000 acfm @ 300° F
Spray Tower Gas Velocity = 8.7 ft/sec
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1400 gpm
Venturi L/G = 30 gal/Mcf
Spray Tower L/G = 70 gal/Mcf
No. of Spray Headers = 4
Residence Times:
  Spray Tower Hold Tank = 13.4 min
  Oxidation Tank = 11.3 min
  Desupersaturation Tank = 4.7 min
Solids Recirculated, Venturi Loop = 12.3-17.8 wt %
Solids Recirculated, Spray Tower Loop = 8.5-8.8 wt %
Venturi Pressure Drop = 9 in. H_2O
Total Pressure Drop, Excl. Mist Elim.
  = 11.5-11.9 in. H_2O
Mist Elim. Pressure Drop = 0.20-0.22 in. H_2O
Air Flow Rate to Oxidizer = 158 scfm
Discharge (Clarifier) Solids
  Concentration = 37-55 wt %
Limestone Addition to Spray Tower EHT
Clarified Liquor Returned to Spray Tower EHT

Figure F-9. OPERATING DATA FOR VENTURI/SPRAY TOWER RUN 810-1A



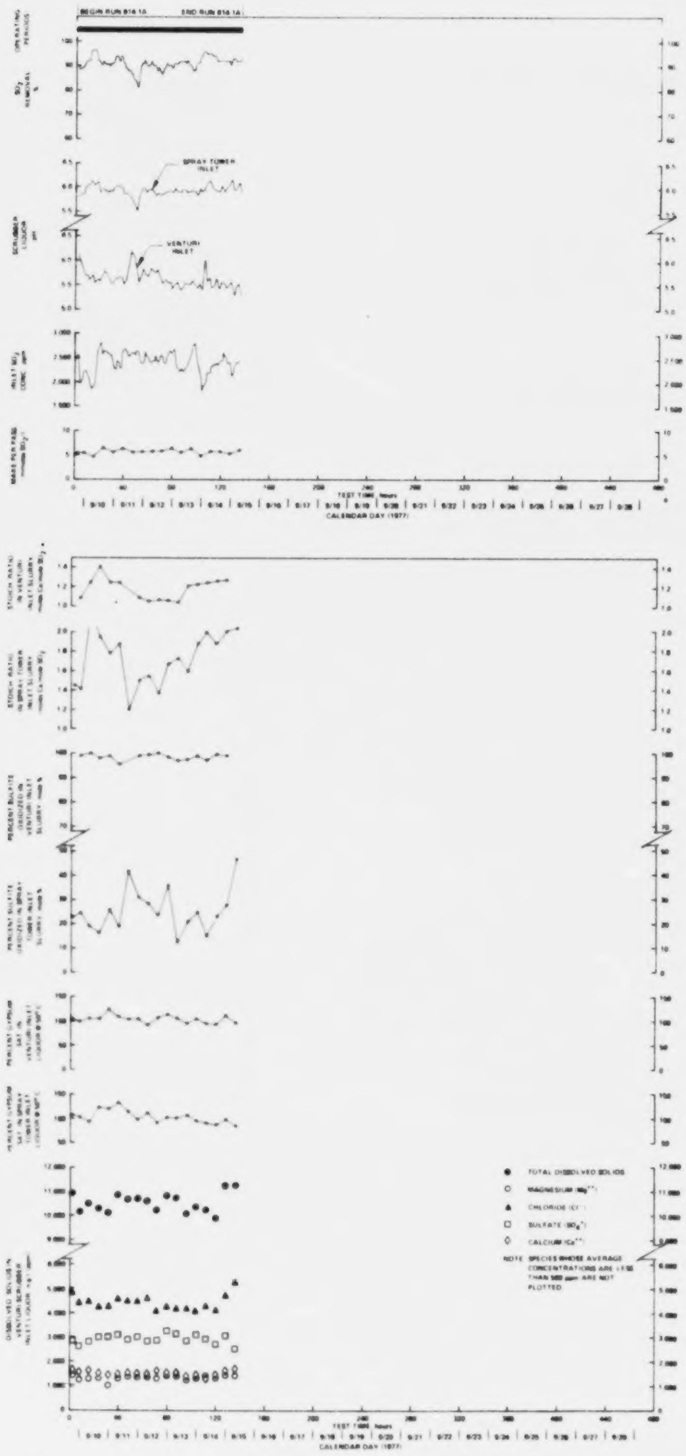
Gas Rate = 25,000 acfm @ 300° F
Spray Tower Gas Velocity = 6.7 ft/sec
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1400 gpm
Venturi L/G = 30 gal/Mcf
Spray Tower L/G = 70 gal/Mcf
No. of Spray Headers = 4
Residence Times:
    Spray Tower Hold Tank = 13.4 min
    Oxidation Tank = 11.3 min
    Desupersaturation Tank = 4.7 min
Solids Recirculated, Venturi Loop = 12.6-16.0 wt %
Solids Recirculated, Spray Tower Loop = 7.0-8.8 wt %
Venturi Pressure Drop = 9 in. H_2O
Total Pressure Drop, Excl. Mist Elim.
    = 11.3-11.9 in. H_2O
Mist Elim. Pressure Drop = 0.30-0.34 in. H_2O
Air Flow Rate to Oxidizer = 150 scfm
Discharge (Clarifier) Solids
    Concentration = 38-62 wt %
Limestone Addition to Spray Tower EHT
Clarified Liquor Returned to Spray Tower EHT

Figure F-10. OPERATING DATA FOR VENTURI/SPRAY TOWER RUN 811-1A



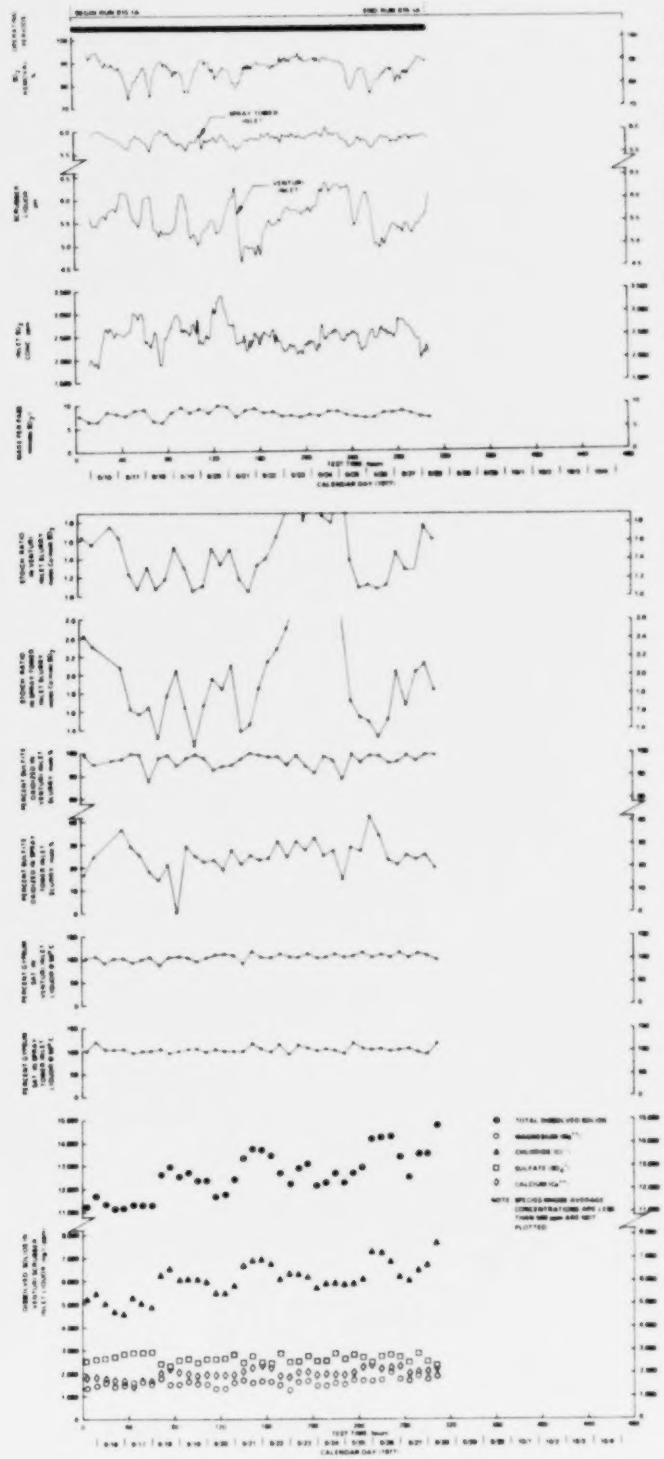
Gas Rate = 25,000 acfm @ 300° F
Spray Tower Gas Velocity = 6.7 ft/sec
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1400 gpm
Venturi L/G = 30 gal/Mcf
Spray Tower L/G = 70 gal/Mcf
No. of Spray Headers = 4
Residence Times
  Spray Tower Hold Tank = 13.4 min
  Oxidation Tank = 11.3 min
  Desupersaturation Tank = -- min
Solids Recirculated, Venturi Loop = 14.6-16.9 wt %
Solids Recirculated, Spray Tower Loop = 6.8-7.9 wt %
Venturi Pressure Drop = 9 in. H_2O
Total Pressure Drop, Excl. Mist Elim.
  = 11.1-12.7 in. H_2O
Mist Elim. Pressure Drop = 0.31-0.36 in. H_2O
Air Flow Rate to Oxidizer = 150 acfm
Discharge (Clarifier & Filter) Solids
  Concentration = 80-92 wt %
Limestone Addition to Spray Tower EHT
Clarified Liquor Returned to Spray Tower EHT

Figure F-11. OPERATING DATA FOR VENTURI/SPRAY TOWER RUN 812-1A



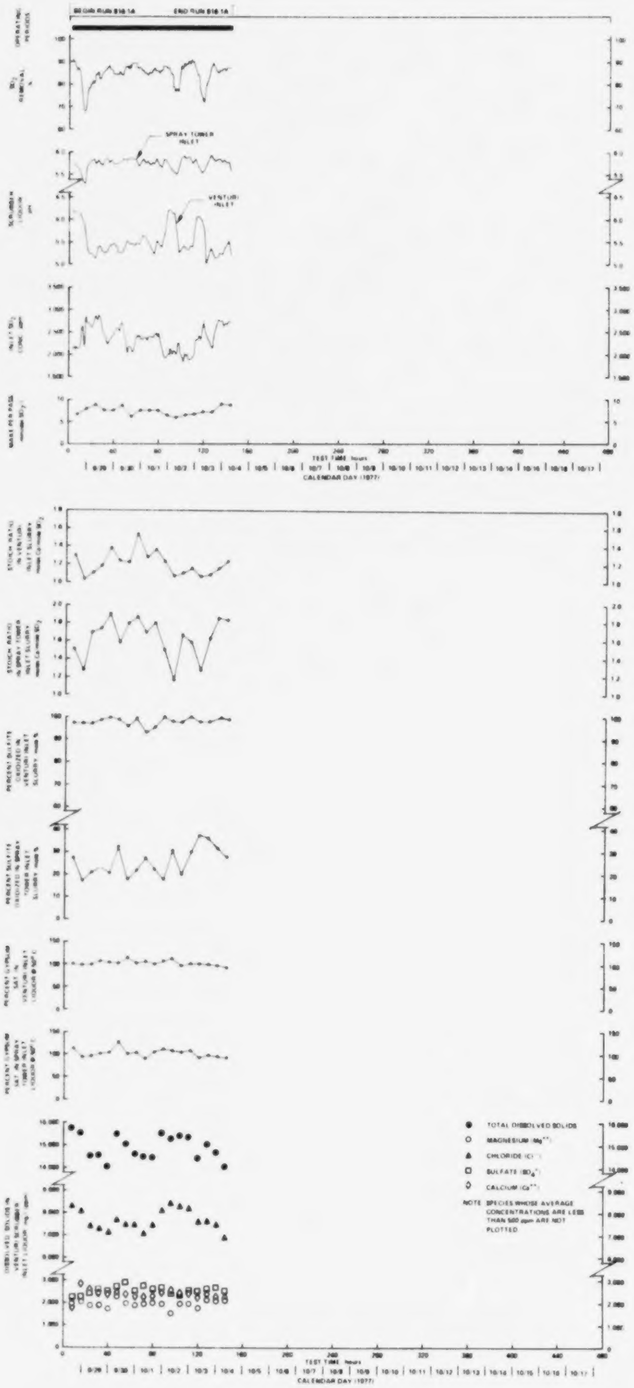
Gas Rate = 25,000 acfm @ 300° F
Spray Tower Gas Velocity = 6.7 ft/sec
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1400 gpm
Venturi L/G = 30 gal/Mcf
Spray Tower L/G = 70 gal/Mcf
No. of Spray Headers = 4
Residence Times
  Spray Tower Hold Tank = 13.4 min
  Oxidation Tank = 8.8 min
  Desupersaturation Tank = 4.7 min
Solids Recirculated, Venturi Loop = 13.7-15.9 wt %
Solids Recirculated, Spray Tower Loop = 7.5-9.2 wt %
Venturi Pressure Drop = 9 in. H_2O
Total Pressure Drop, Excl. Mist Elim.
  = 11.4-12.5 in. H_2O
Mist Elim. Pressure Drop = 0.32-0.38 in. H_2O
Air Flow Rate to Oxidizer = 150 scfm
Discharge (Clarifier & Filter) Solids
  Concentration = 84-92 wt %
Limestone Addition to Spray Tower EHT
Clarified Liquor Returned to Spray Tower EHT

Figure F-12. OPERATING DATA FOR VENTURI/SPRAY TOWER 814-1A



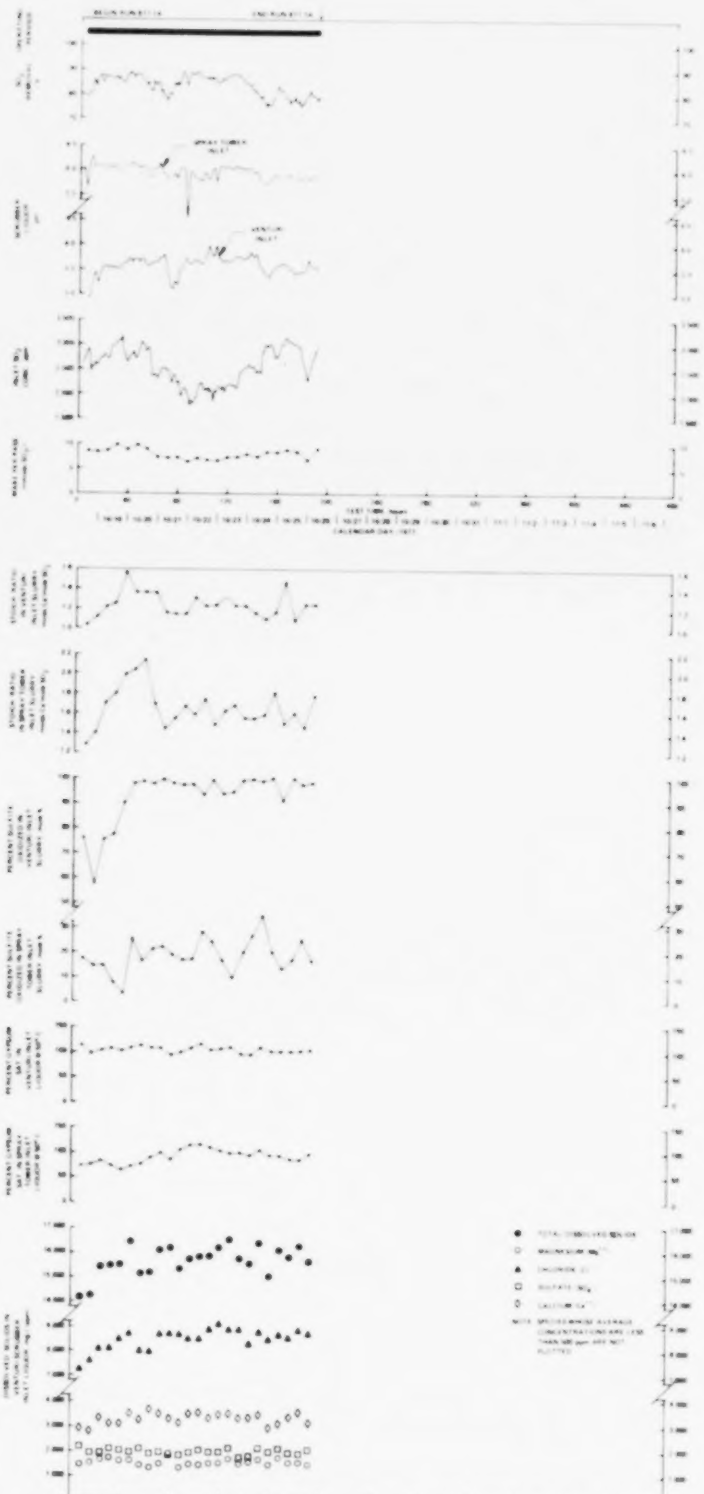
Gas Rate = 35,000 acfm @ 300° F
Spray Tower Gas Velocity = 9.4 ft/sec
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1400 gpm
Venturi L/G = 21 gal/Mcf
Spray Tower L/G = 50 gal/Mcf
No. of Spray Headers = 4
Residence Times:
  Spray Tower Hold Tank = 13.4 min
  Oxidation Tank = 8.8 min
  Desupersaturation Tank = 4.7 min
Solids Recirculated, Venturi Loop = 13.8-16.3 wt %
Solids Recirculated, Spray Tower Loop = 7.0-8.8 wt %
Venturi Pressure Drop = 9 in. H_2O
Total Pressure Drop, Excl. Mist Elim.
  = 14.8-17.3 in. H_2O
Mist Elim. Pressure Drop = 0.50-0.70 in. H_2O
Air Flow Rate to Oxidizer = 210 scfm
Discharge (Clarifier & Filter) Solids
  Concentration = 82-87 wt %
Limestone Addition to Spray Tower EHT
Clarified Liquor Returned to Spray Tower EHT

Figure F-13. OPERATING DATA FOR VENTURI/SPRAY TOWER RUN 815-1A



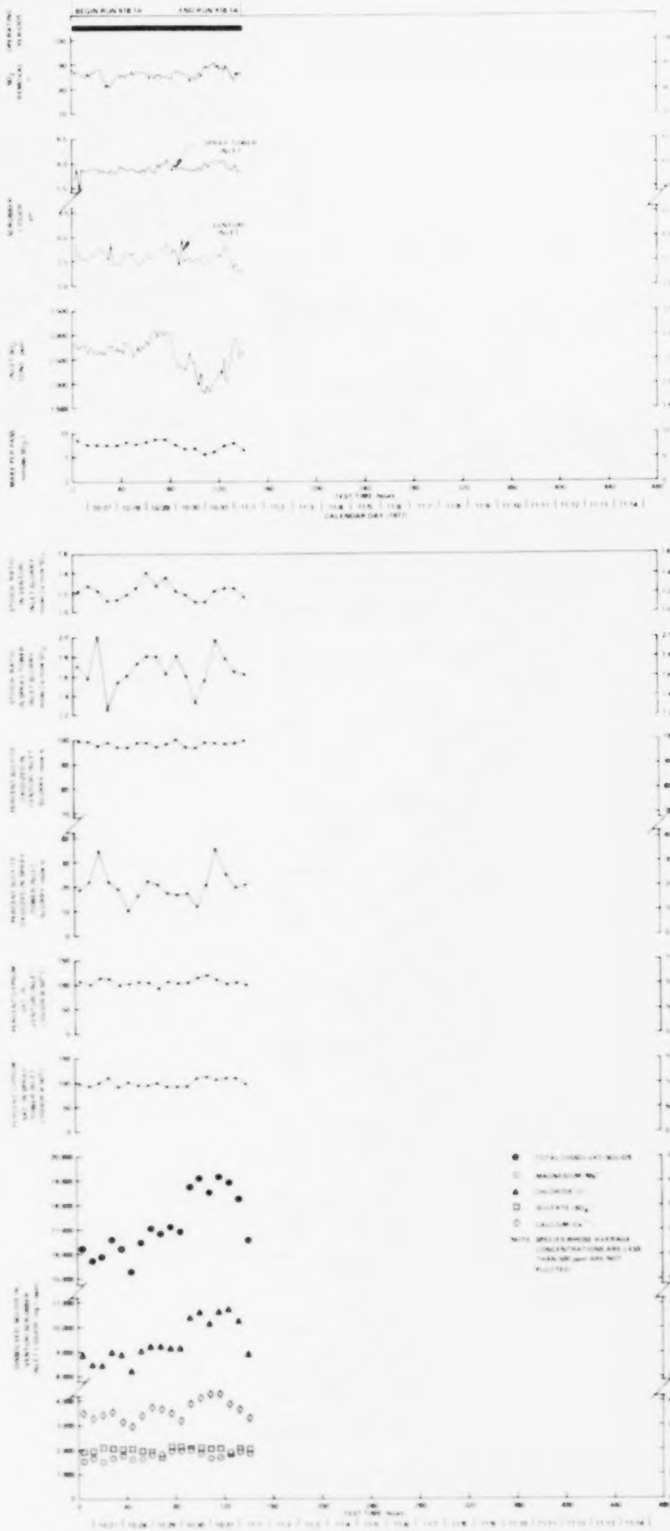
Gas Rate = 35,000 acfm @ 300° F
Spray Tower Gas Velocity = 9.4 ft/sec
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1400 gpm
Venturi L/G = 21 gal/Mcf
Spray Tower L/G = 50 gal/Mcf
No. of Spray Headers = 4
Residence Times
  Spray Tower Hold Tank = 13.4 min
  Oxidation tank = 11.3 min
  Desupersaturation Tank = 4.7 min
Solids Recirculated, Venturi Loop = 13.4-16.2 wt %
Solids Recirculated, Spray Tower Loop = 6.5-8.0 wt %
Venturi Pressure Drop = 9 in. H_2O
Total Pressure d Drop, Excl. Mist Elim.
  = 15.6-16.0 in. H_2O
Mist Elim. Pressure Drop = 0.58-0.70 in. H_2O
Air Flow Rate to Oxidizer = 210 scfm
Discharge (Clarifier & Filter) Solids
  Concentration = 61-81 wt %
Limestone Addition to Spray Tower EHT
Clarified Liquor Returned to Spray Tower EHT

Figure F-14. OPERATING DATA FOR VENTURI/SPRAY TOWER RUN 816-1A



Gas Rate = 35,000 acfm @ 300° F
Spray Tower Gas Velocity = 9.4 ft/sec
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1400 gpm
Venturi L/G = 21 gal/Mcf
Spray Tower L/G = 50 gal/Mcf
No. of Spray Headers = 4
Residence Times
  Spray Tower Hold Tank = 16.8 min
  Oxidation Tank = 11.3 min
  Desupersaturation Tank = 4.7 min
Solids Recirculated, Venturi Loop = 15.1-16.4 wt %
Solids Recirculated, Spray Tower Loop = 8.0-9.7 wt %
Venturi Pressure Drop = 9 in. H_2O
Total Pressure Drop, Excl. Mist Elim.
  = 14.6-16.0 in. H_2O
Mist Elim. Pressure Drop = 0.55-0.66 in. H_2O
Air Flow Rate to Oxidizer = 210 scfm
Discharge (Clarifier & Filter) Solids
  Concentration = 82-89 wt %
Limestone Addition to Spray Tower EHT
Clarified Liquor Returned to Oxidation Tank

Figure F-15. OPERATING DATA FOR VENTURI/SPRAY TOWER RUN 817-1A



Gas Rate = 35,000 acfm @ 300° F
Spray Tower Gas Velocity = 9.4 ft/sec
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1600 gpm
Venturi L/G = 21 gal/Mcf
Spray Tower L/G = 57 gal/Mcf
No. of Spray Headers = 4
Residence Times
Spray Tower Hold Tank = 14.7 min
Oxidation Tank = 11.3 min
Desupersaturation Tank = 4.7 min
Solids Recirculated, Venturi Loop = 14.0-15.8 wt %
Solids Recirculated, Spray Tower Loop = 8.7-10.4 wt %
Venturi Pressure Drop = 9 in. H_2O
Total Pressure Drop, Excl. Mist Elim.
= 14.1-15.9 in. H_2O
Mist Elim. Pressure Drop = 0.57-0.68 in. H_2O
Air Flow Rate to Oxidizer = 210 scfm
Discharge (Clarifier & Filter) Solids
Concentration = 82-89 wt %
Limestone Addition to Spray Tower EHT
Clarified Liquor Returned to Oxidation Tank

Figure F-16. OPERATING DATA FOR VENTURI/SPRAY TOWER RUN 818-1A

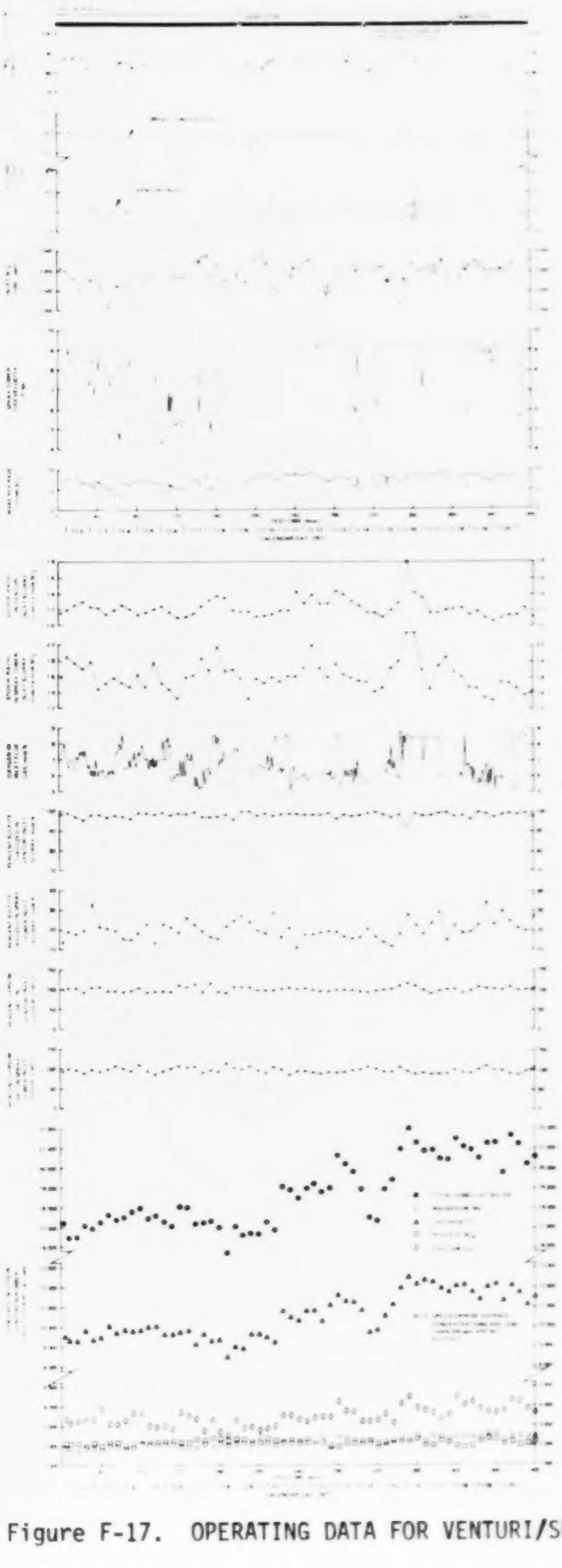
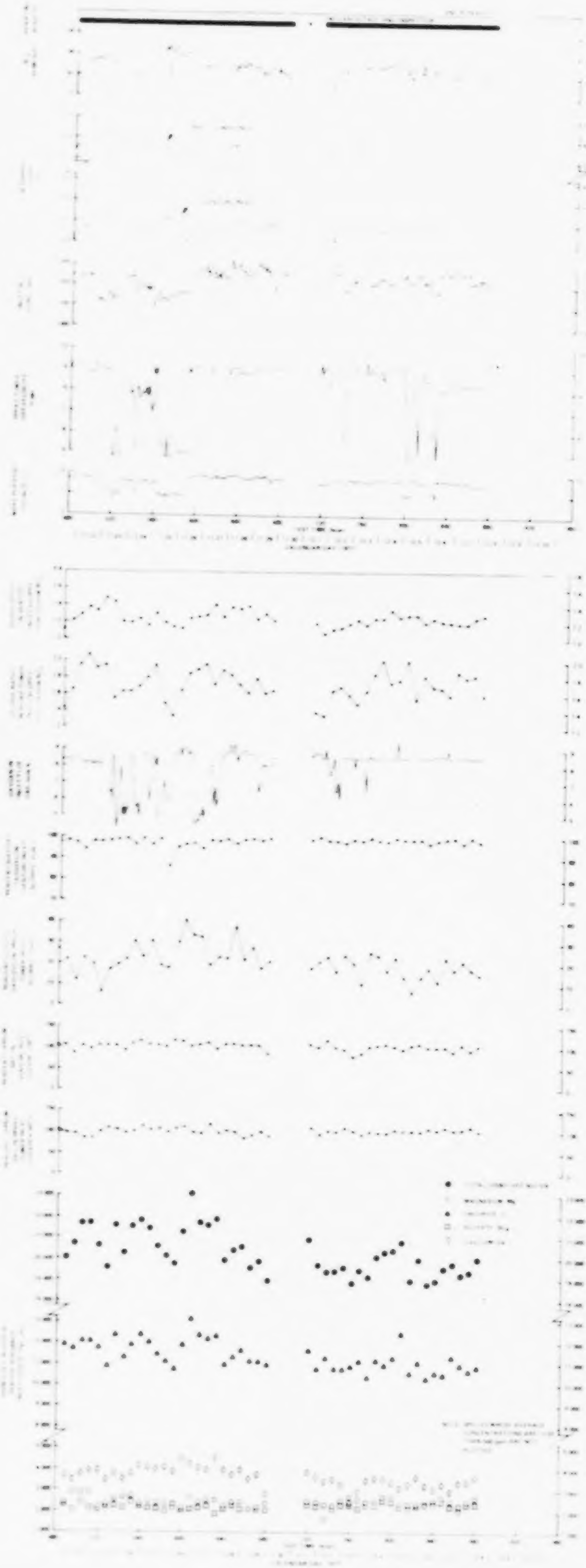
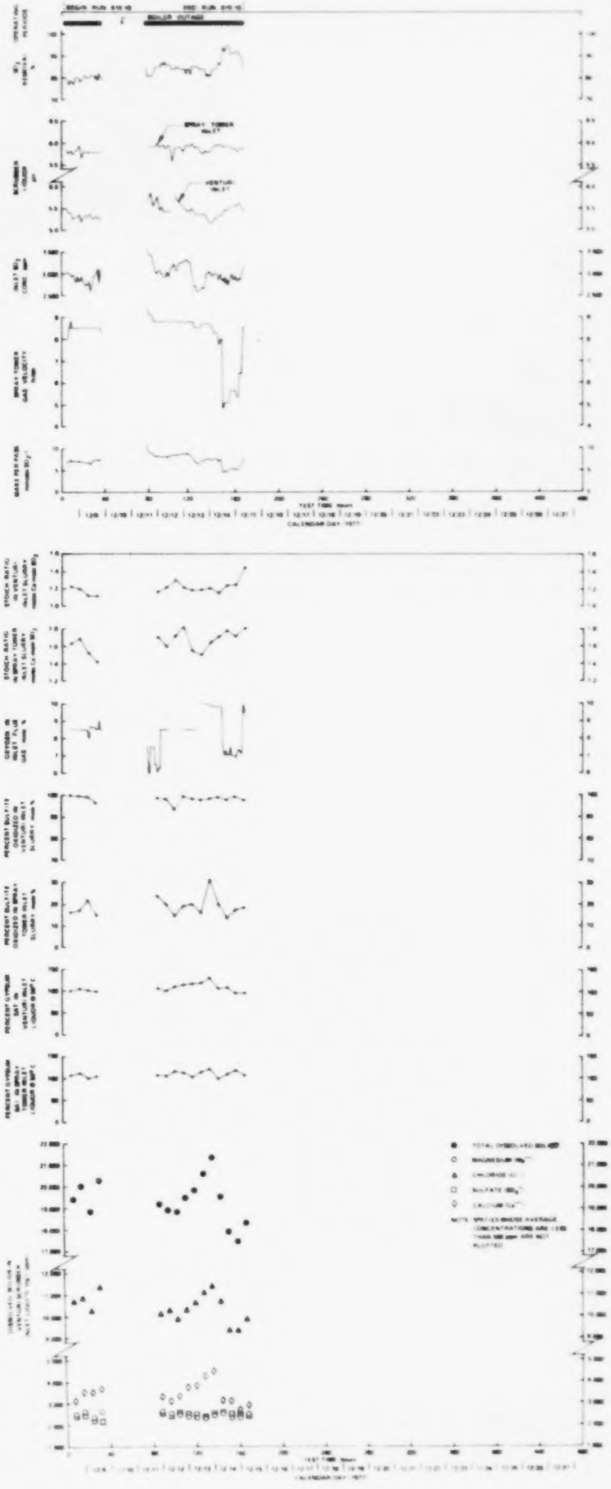


Figure F-17. OPERATING DATA FOR VENTURI/SPRAY TOWER RUN 819-1A



Gas Rate - 18,000-35,000 acfm @ 300° F
Spray Tower Gas Velocity - 4.8-9.4 ft/sec
Liquor Rate to Venturi - 600 gpm
Liquor Rate to Spray Tower - 1600 gpm
Venturi L/G - 21-42 gal/Mcf
Spray Tower L/G - 57-111 gal/Mcf
No. of Spray Headers - 4
Residence Times
  Spray Tower Hold Tank - 14.7 min
  Oxidation Tank - 11.3 min
  Desupersaturation Tank - 4.7 min
Solids Recirculated, Venturi Loop - 13.0-16.9 wt %
Solids Recirculated, Spray Tower Loop - 8.1-11.5 wt %
Venturi Pressure Drop - 3.0-9.3 in. H_2O
Total Pressure Drop, Excl. Mist Elim.
  - 5.8-15.9 in. H_2O
Mist Elim. Pressure Drop - 0.18-0.86 in. H_2O
Air Flow Rate to Oxidizer - 210 scfm
Discharge (Clar. & Fil./Lamella Settler) Solids
  Concentration - 83-91 wt %
Limestone Addition to Spray Tower EHT
Clarified Liquor Returned to Oxidation Tank

Figure F-17 (continued). OPERATING DATA FOR VENTURI/SPRAY TOWER RUN 819-1A



Gas Rate = 18,000-35,000 acfm @ 300° F
Spray Tower Gas Velocity = 4.8-9.4 ft/sec
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1600 gpm
Venturi L/G = 21-42 gal/Mcf
Spray Tower L/G = 57-111 gal/Mcf
No. of Spray Headers = 4
Residence Times
    Spray Tower Hold Tank = 14.7 min
    Oxidation Tank = 11.3 min
    Desupersaturation Tank = 4.7 min
Solids Recirculated, Venturi Loop = 13.8-16.6 wt %
Solids Recirculated, Spray Tower Loop = 8.6-10.5 wt %
Venturi Pressure Drop = 5.5-9.1 in. H_2O
Total Pressure Drop, Excl. Mist Elim.
    = 10.8-14.3 in. H_2O
Mist Elim. Pressure Drop = 0.24-0.82 in. H_2O
Air Flow to Oxidizer = 210 scfm
Discharge (Clarifier & Filter) Solids
    Concentration = 82-89 wt %
Limestone Addition to Spray Tower EHT
Clarified Liquor Returned to Oxidation Tank

Figure F-18. OPERATING DATA FOR VENTURI/SPRAY TOWER RUN 819-1A

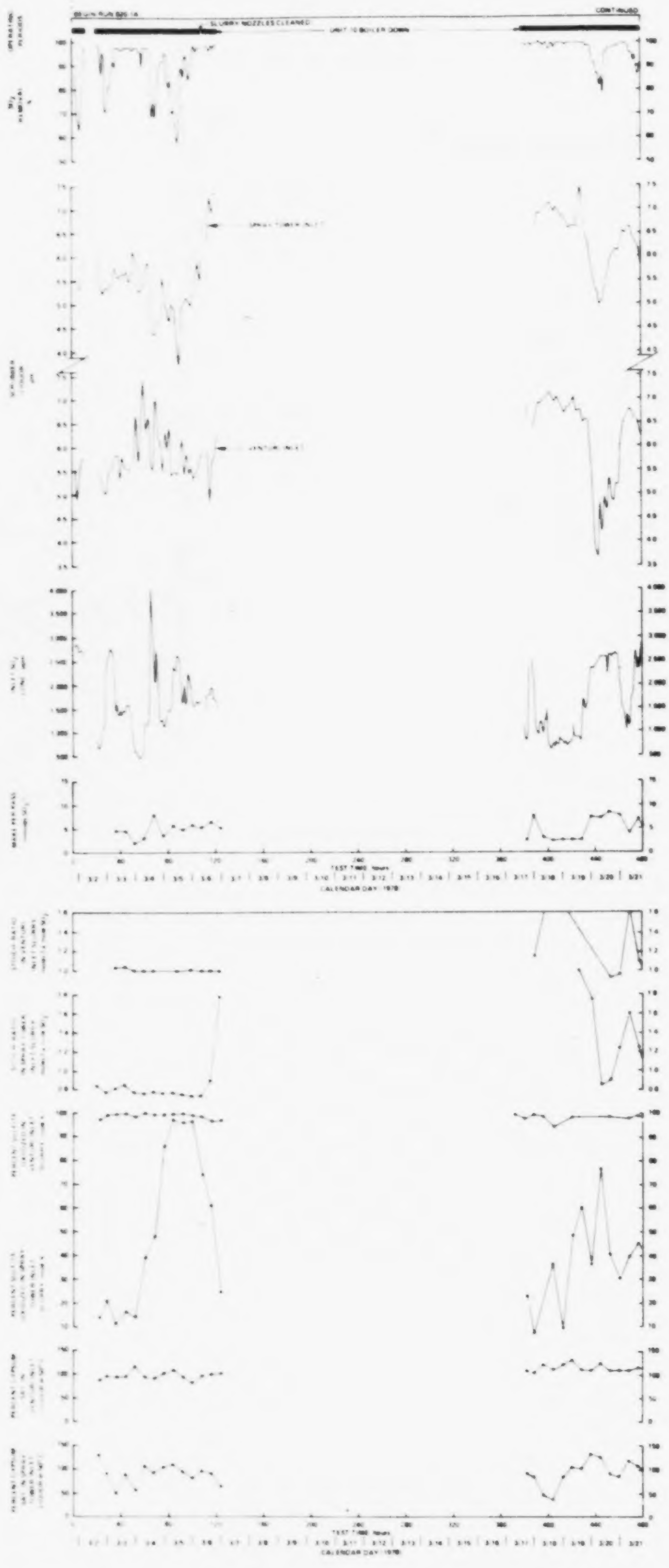


Figure F-19. OPERATING DATA FOR VENTURI/SPRAY TOWER RUN 820-1A

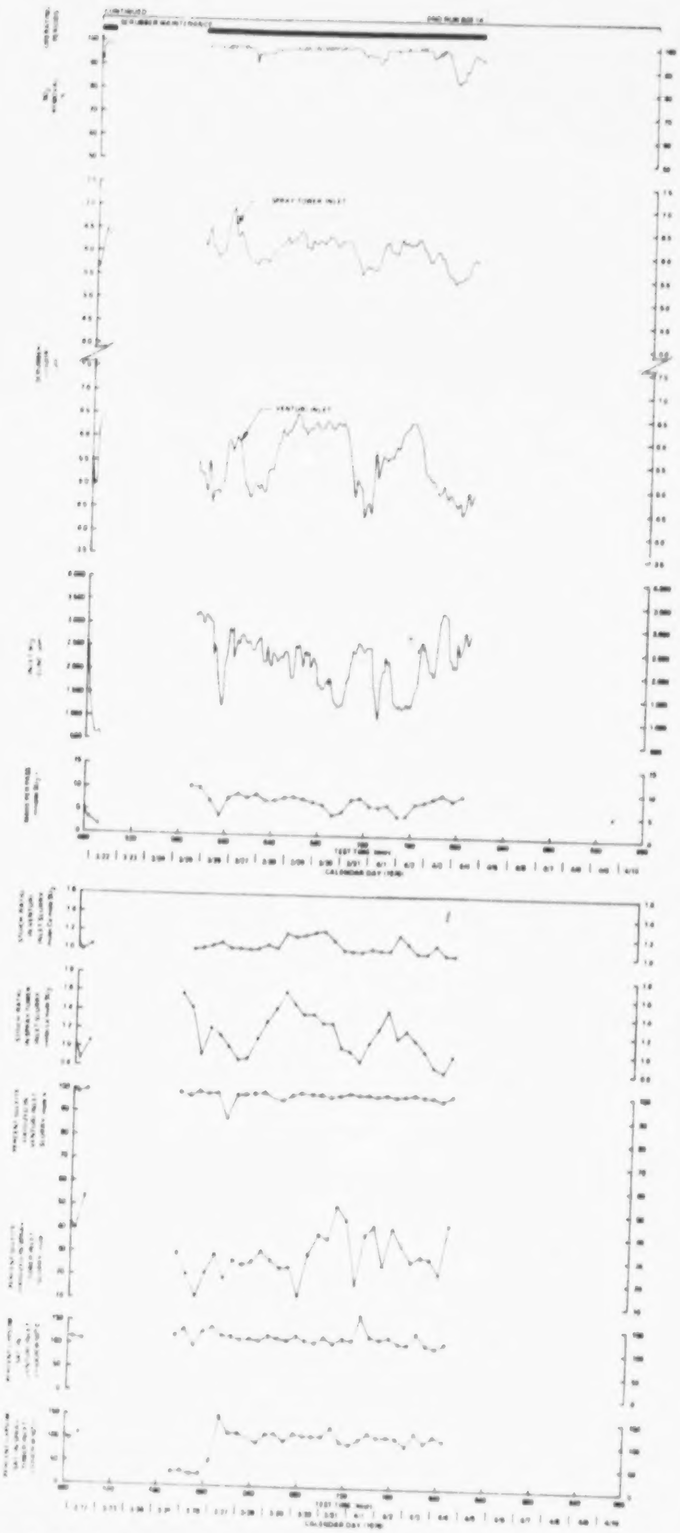


Figure F-19 (continued). OPERATING DATA FOR VENTURI/SPRAY TOWER RUN 820-1A

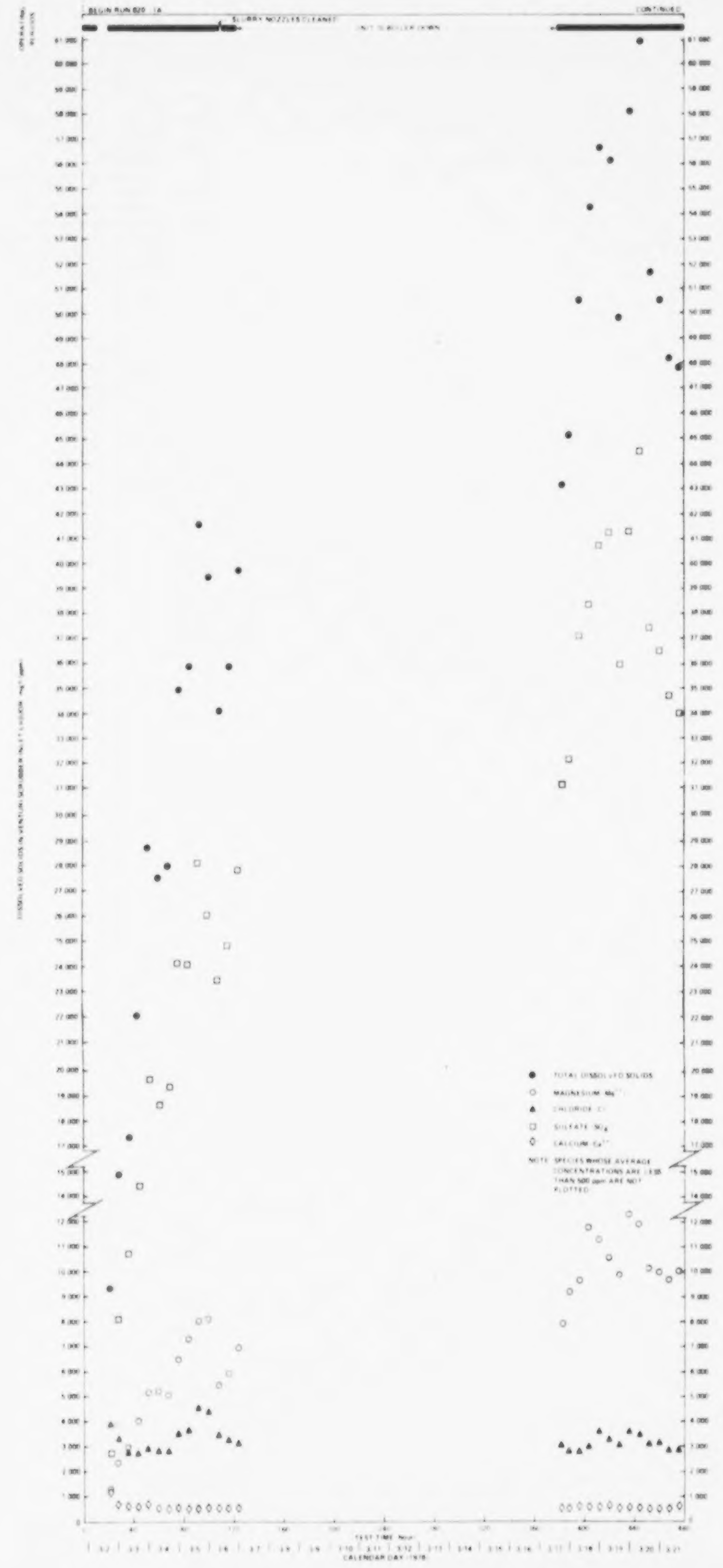
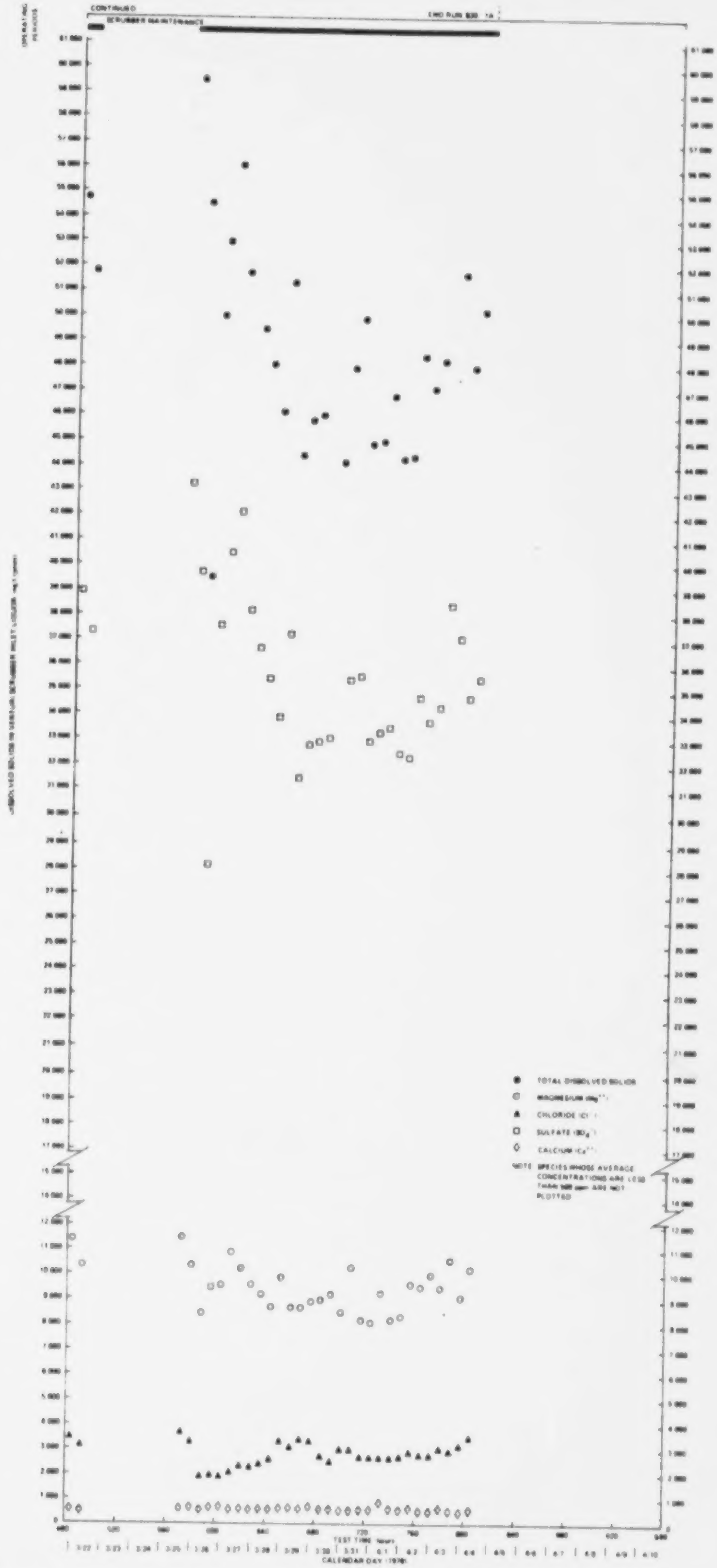


Figure F-19 (continued). OPERATING DATA FOR VENTURI/SPRAY TOWER RUN 820-1A



Gas Rate = 35,000 acfm @ 300° F
Spray Tower Gas Velocity = 9.4 ft/sec @ 125° F
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1600 gpm
Venturi L/G = 21 gal/Mcf
Spray Tower L/G = 57 gal/Mcf
No. of Spray Headers = 4
Residence Times:
  Spray Tower Hold Tank = 14.7 min
  Oxidation Tank = 11.3 min
  Desupersaturation Tank = 4.7 min
Solids Recirculated, Venturi Loop = 12.1-16.8 wt %
Solids Recirculated, Spray Tower Loop = 3.8-8.2 wt %
Venturi Pressure Drop = 9 in. H_2O
Total Pressure Drop, Excl. Mist Elim.
  = 14.0-17.3 in. H_2O
Mist Elim. Pressure Drop = 0.52-0.68 in. H_2O
Air Flow Rate to Oxidizer = 210 scfm
Discharge (Clarifier & Filter) Solids
  Concentration = 82-88 wt %
Limestone Addition to Spray Tower EHT
MgO dry fed to Spray Tower EHT
Clarified Liquor Returned to Oxidation Tank

Figure F-19 (continued). OPERATING DATA FOR VENTURI/SPRAY TOWER RUN 820-1A

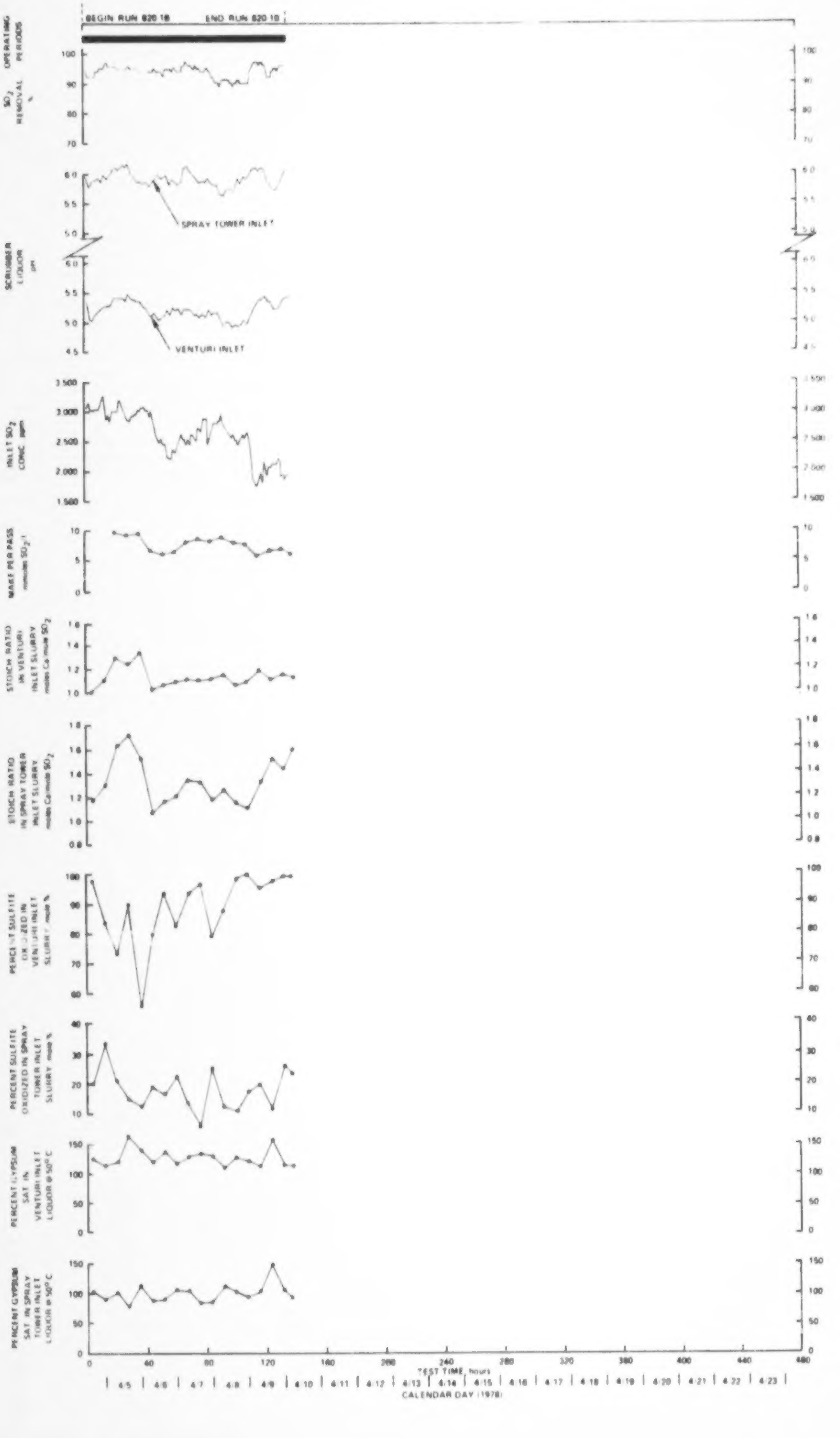
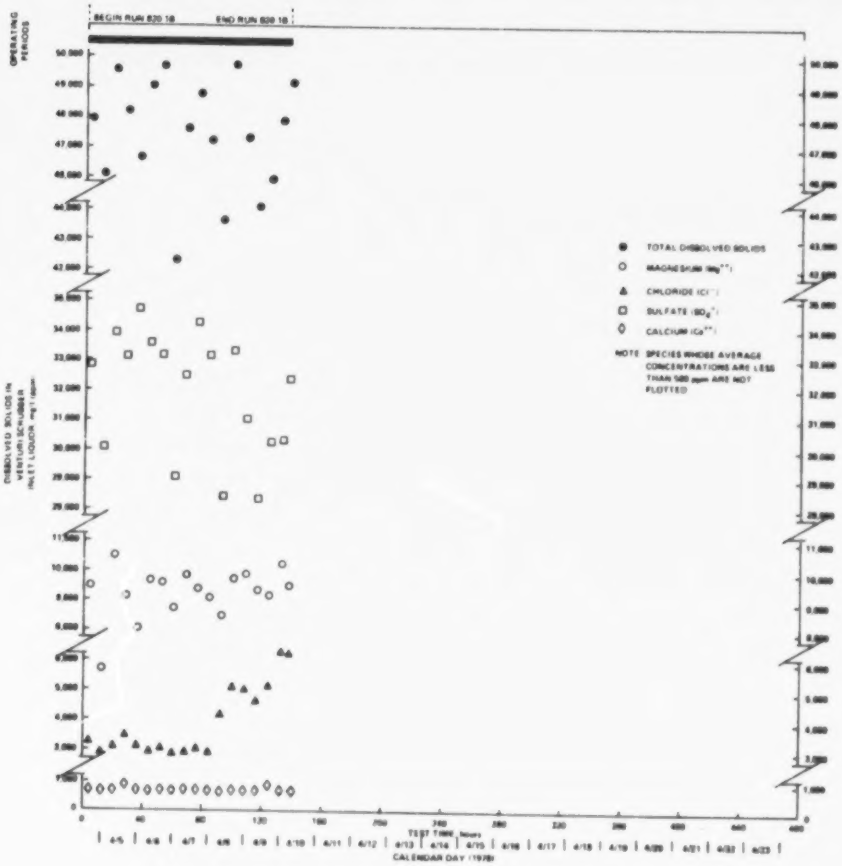


Figure F-20. OPERATING DATA FOR VENTURI/SPRAY TOWER RUN 820-1B



Gas Rate = 35,000 acfm @ 300° F
Spray Tower Gas Velocity = 9.4 ft/sec @ 125° F
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1600 gpm
Venturi L/G = 21 gal/Mcf
Spray Tower L/G = 57 gal/Mcf
No. of Spray Headers = 4
Residence Times
  Spray Tower Hold Tank = 14.7 min
  Oxidation Tank = 11.3 min
  Desupersaturation Tank = 4.7 min
Solids Recirculated, Venturi Loop = 13.4 - 15.6 wt %
Solids Recirculated, Spray Tower Loop = 7.6 - 8.9 wt %
Venturi Pressure Drop = 9 in. H_2O
Total Pressure Drop, Excl. Mist Elim.
  = 14.7 - 16.9 in. H_2O
Mist Elim. Pressure Drop = 0.58 - 0.66 in. H_2O
Air Flow Rate to Oxidizer = 150 scfm
Discharge (Clarifier & Filter) Solids
  Concentration = 78 - 86 wt %
Limestone and MgO dry Addition to Spray Tower EHT
Clarified Liquor Returned to Oxidation Tank

Figure F-20 (continued). OPERATING DATA FOR VENTURI/SPRAY TOWER RUN 820-1B

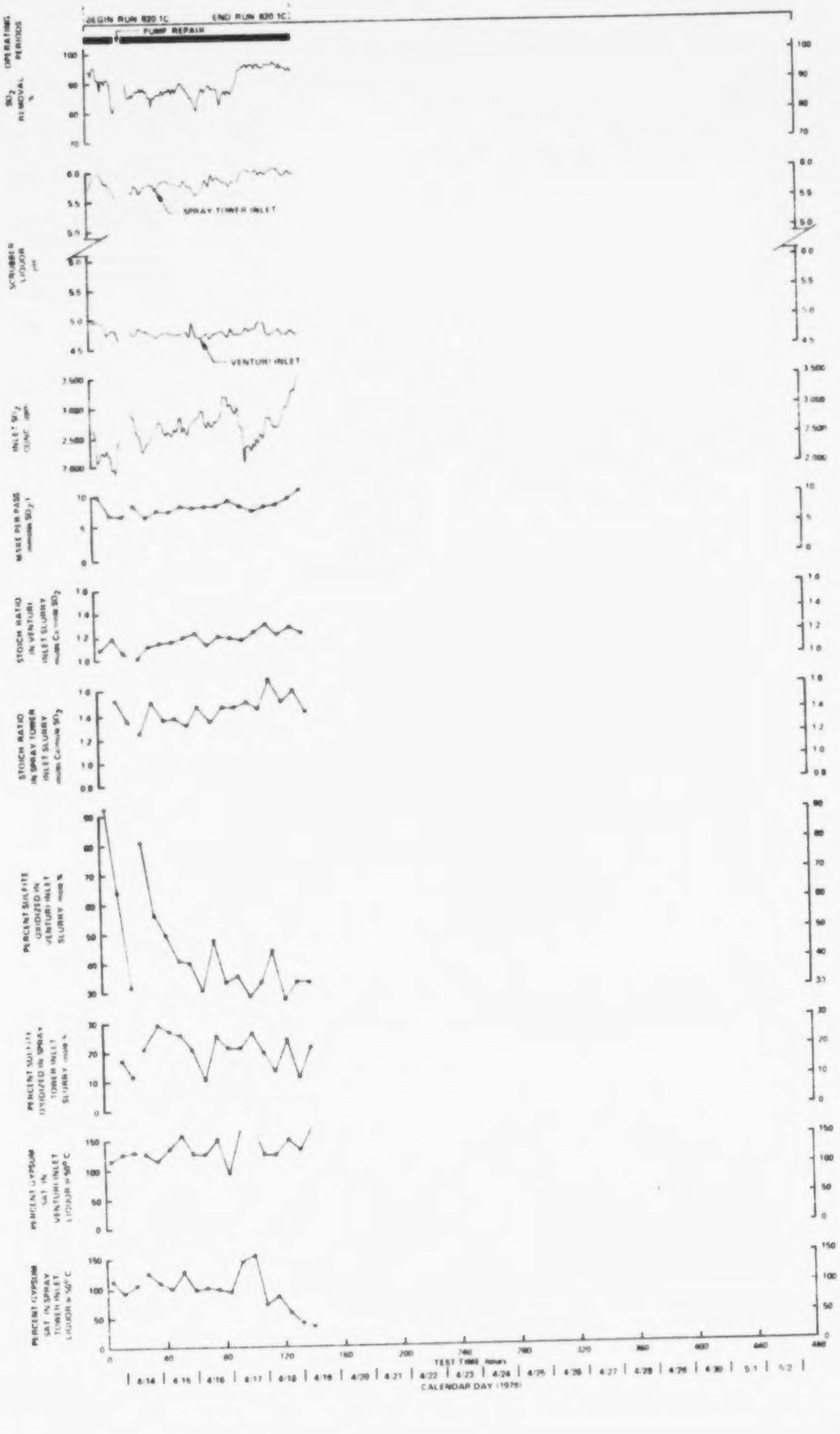
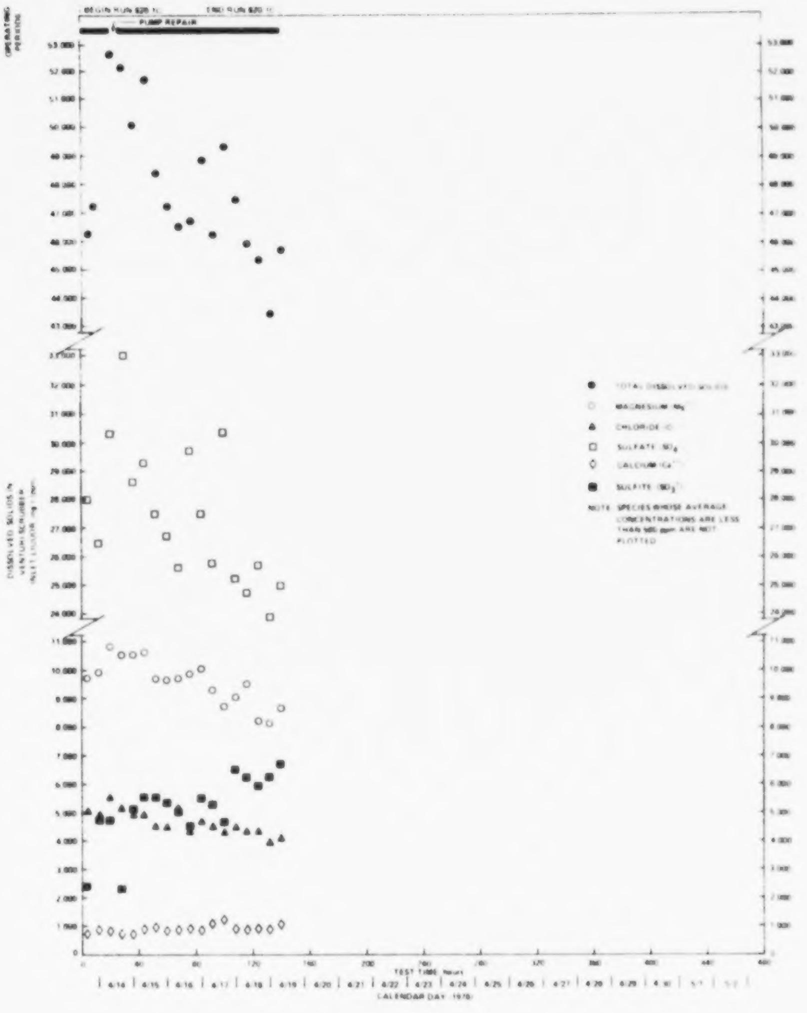


Figure F-21. OPERATING DATA FOR VENTURI/SPRAY TOWER RUN 820-1C



Gas Rate = 35,000 acfm @ 300° F
Spray Tower Gas Velocity = 9.4 ft/sec @ 125° F
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1600 gpm
Venturi L/G = 21 gal/Mcf
Spray Tower L/G = 57 gal/Mcf
No. of Spray Headers = 4
Residence Times
  Spray Tower Hold Tank = 14.7 min
  Oxidation Tank = 11.3 min
  Desupersaturation Tank = 4.7 min
Solids Recirculated, Venturi Loop = 14.2 - 16.0 wt %
Solids Recirculated, Spray Tower = 9.5 - 11.5 wt %
Venturi Pressure Drop = 9 in. H_2O
Total Pressure Drop, Excl. Mist Elim.
  = 13.6 - 17.3 in. H_2O
Mist Elim. Pressure Drop = 0.43 - 0.72 in. H_2O
Air Flow Rate to Oxidizer = 0 scfm
Discharge (Clarifier & Filter) Solids
  Concentration = 55 - 71 wt %
Limestone and MgO dry Addition to Spray Tower EHT
Clarified Liquor Returned to Oxidation Tank

Figure F-21 (continued). OPERATING DATA FOR VENTURI/SPRAY TOWER RUN 820-1C

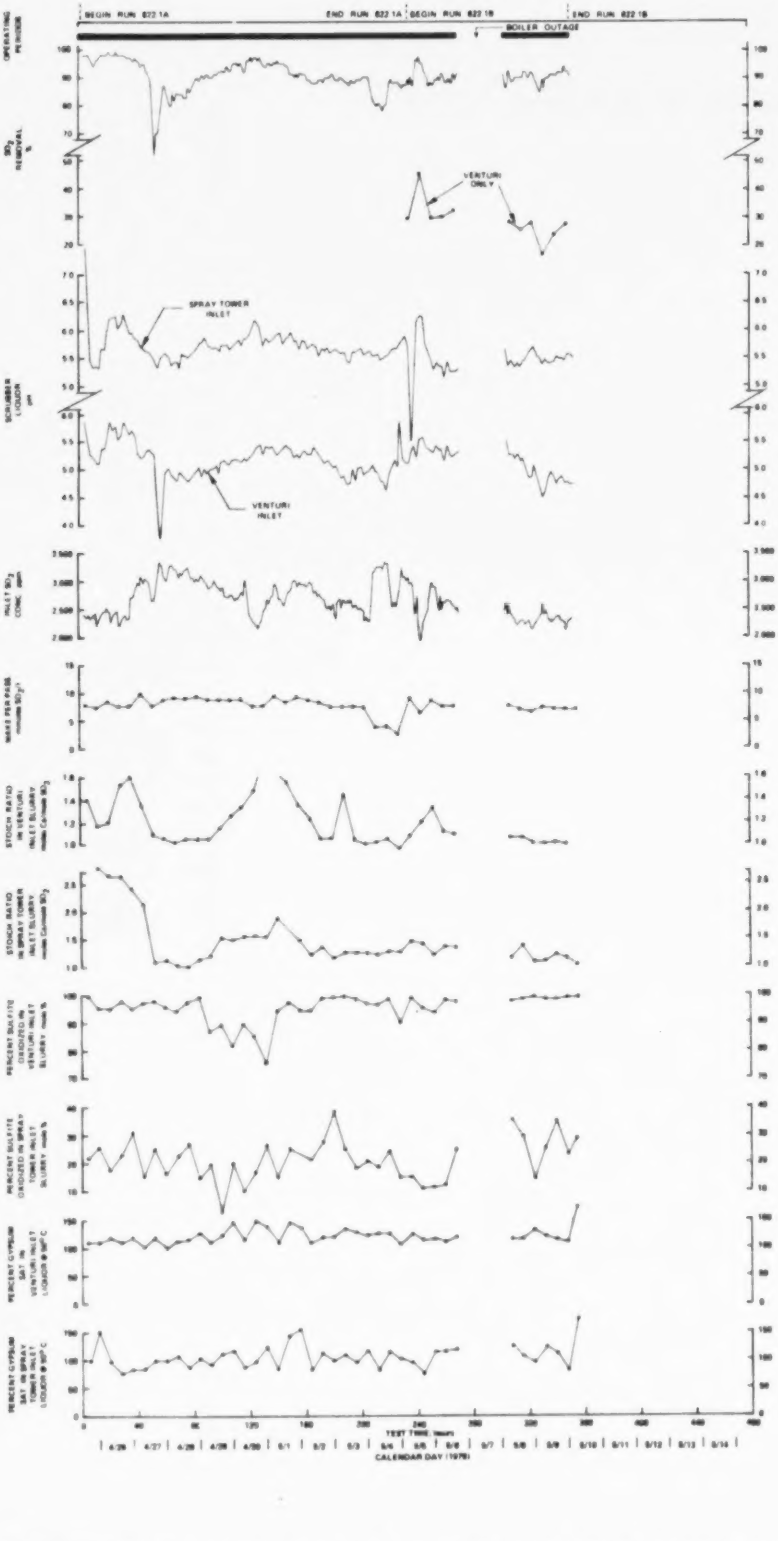
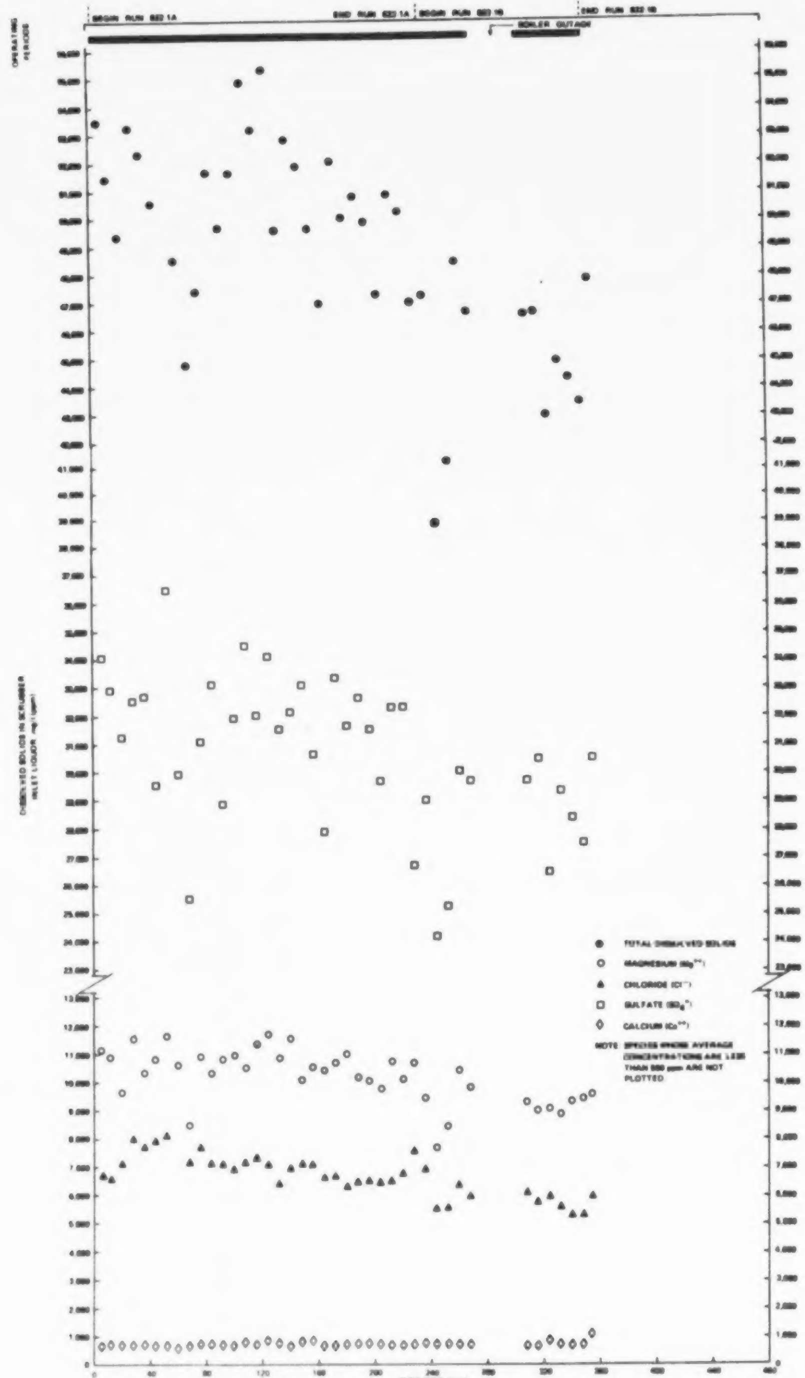


Figure F-22. OPERATING DATA FOR VENTURI/SPRAY TOWER RUNS 822-1A & 822-1B



822 - 1A

Gas Rate - 35,000 acfm @ 300° F
Spray Tower Gas Velocity = 9.4 ft/sec @ 125° F
Liquor Rate to Venturi - 600 gpm
Liquor Rate to Spray Tower - 1600 gpm
Venturi L/G = 21 gal/Mcf
Spray Tower L/G = 57 gal/Mcf
No. of Spray Headers = 4
Residence Times:
Spray Tower Hold Tank = 14.7 min
Oxidation Tank = 11.3 min
Desupersaturation Tank = 4.7 min
Solids Recirculated, Venturi Loop = 12.5 - 16.1 wt %
Solids Recirculated, Spray Tower Loop = 6.6 - 9.4 wt %
Venturi Pressure Drop = 9 in. H_2O
Total Pressure Drop, Excl. Mist Elim.
= 14.0 - 17.4 in. H_2O
Mist Elim. Pressure Drop = 0.42 - 0.56 in. H_2O
Air Flow to Oxidizer = 210 scfm
Discharge (Clarifier & Filter) Solids
Concentration = 80 - 90 wt %
Limestone and Dry MgO Addition to Spray Tower EHT,
Clarified Liquor Returned to Oxidation Tank

822 - 1B

Gas Rate = 35,000 acfm @ 300° F
Spray Tower Gas Velocity = 9.4 ft/sec @ 125° F
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1600 gpm
Venturi L/G = 21 gal/Mcf
Spray Tower L/G = 57 gal/Mcf
No. of Spray Headers = 4
Residence Times:
Spray Tower Hold Tank = 14.7 min
Oxidation Tank = 11.3 min
Desupersaturation Tank = 4.7 min
Solids Recirculated, Venturi Loop = 11.4 - 15.2 wt %
Solids Recirculated, Spray Tower Loop = 4.6 - 6.6 wt %
Venturi Pressure Drop = 9 in. H_2O
Total Pressure Drop = , Excl. Mist Elim.
= 13.9 - 15.6 in. H_2O
Mist Elim. Pressure Drop = 0.41 - 0.52 in. H_2O
Air Flow Rate to Oxidizer = 210 scfm
Discharge (Clarifier & Filter) Solids
Concentration = 80 - 89 wt %
Limestone and Dry MgO Addition to Spray Tower EHT
Clarified Liquor Returned to Oxidation Tank

Figure F-22 (continued). OPERATING DATA FOR VENTURI/SPRAY TOWER RUNS 822-1A & 822-1B

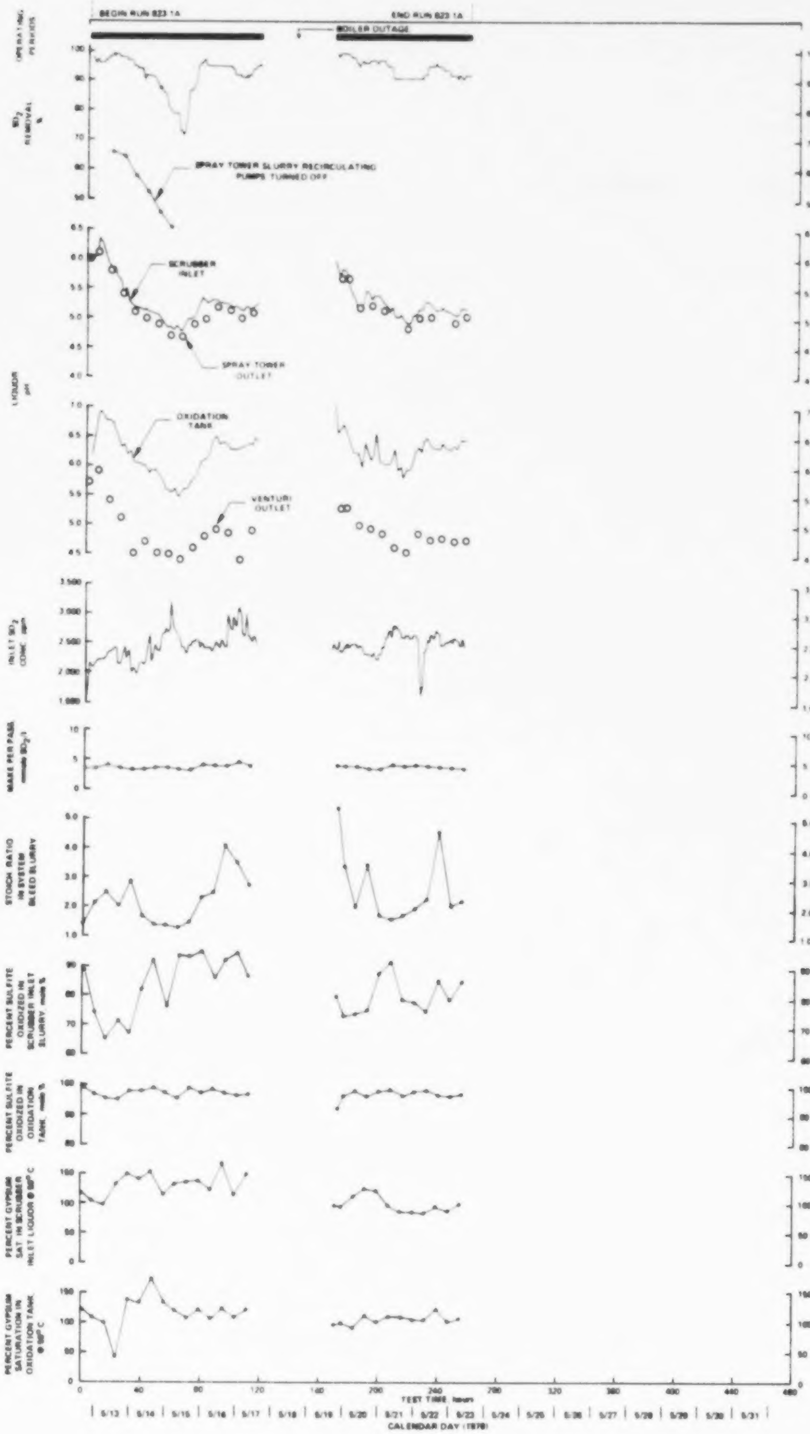
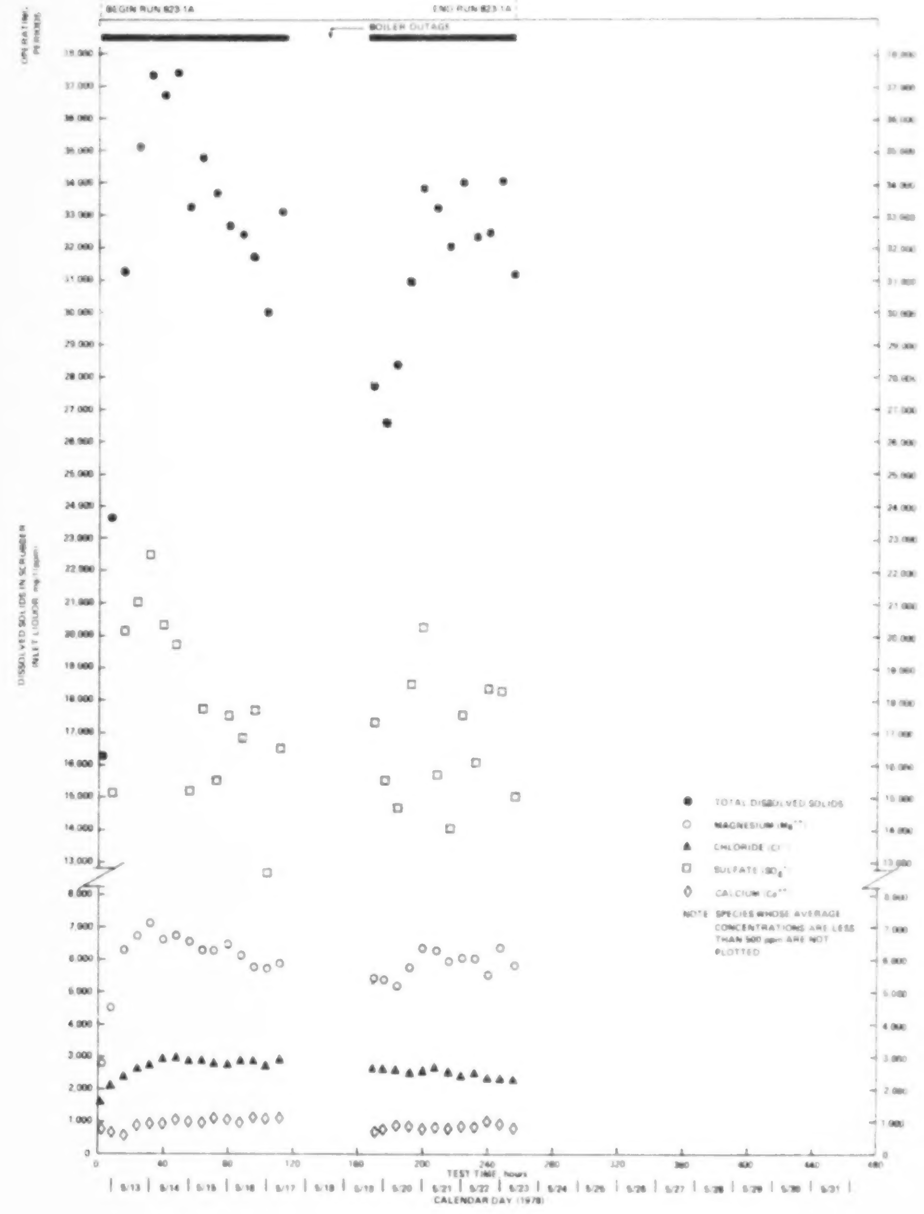


Figure F-23. OPERATING DATA FOR VENTURI/SPRAY TOWER RUN 823-1A



Gas Rate = 18,000 acfm @ 300° F
Spray Tower Gas Velocity = 4.6 ft/sec @ 125° F
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1600 gpm
Venturi L/G = 42 gal/Mcf
Spray Tower L/G = 111 gal/Mcf
No. of Spray Headers 4
Effluent Hold Tank Residence Time = 11.7 min
Oxidation Tank Level = 18 ft
Percent Solids Recirculated = 11.0 - 15.6 wt %
Venturi Pressure Drop = 9 in. H_2O
Total Pressure Drop, Excl. Mist Elim.
= 11.3 - 12.6 in. H_2O
Mist Elim. Pressure Drop = 0.14 - 0.23 in. H_2O
Air Flow Rate to Oxidizer = 110 scfm
Discharge (Clarifier & Filter) Solids
Concentration = 79 - 87 wt %
Limestone and Dry MgO Addition to EHT
Clarified Liquor Returned to EHT
Recycle Slurry Flow from Oxidation Tank
to EHT = 30 gpm

Figure F-23 (continued). OPERATING DATA FOR VENTURI/SPRAY TOWER RUN 823-1A

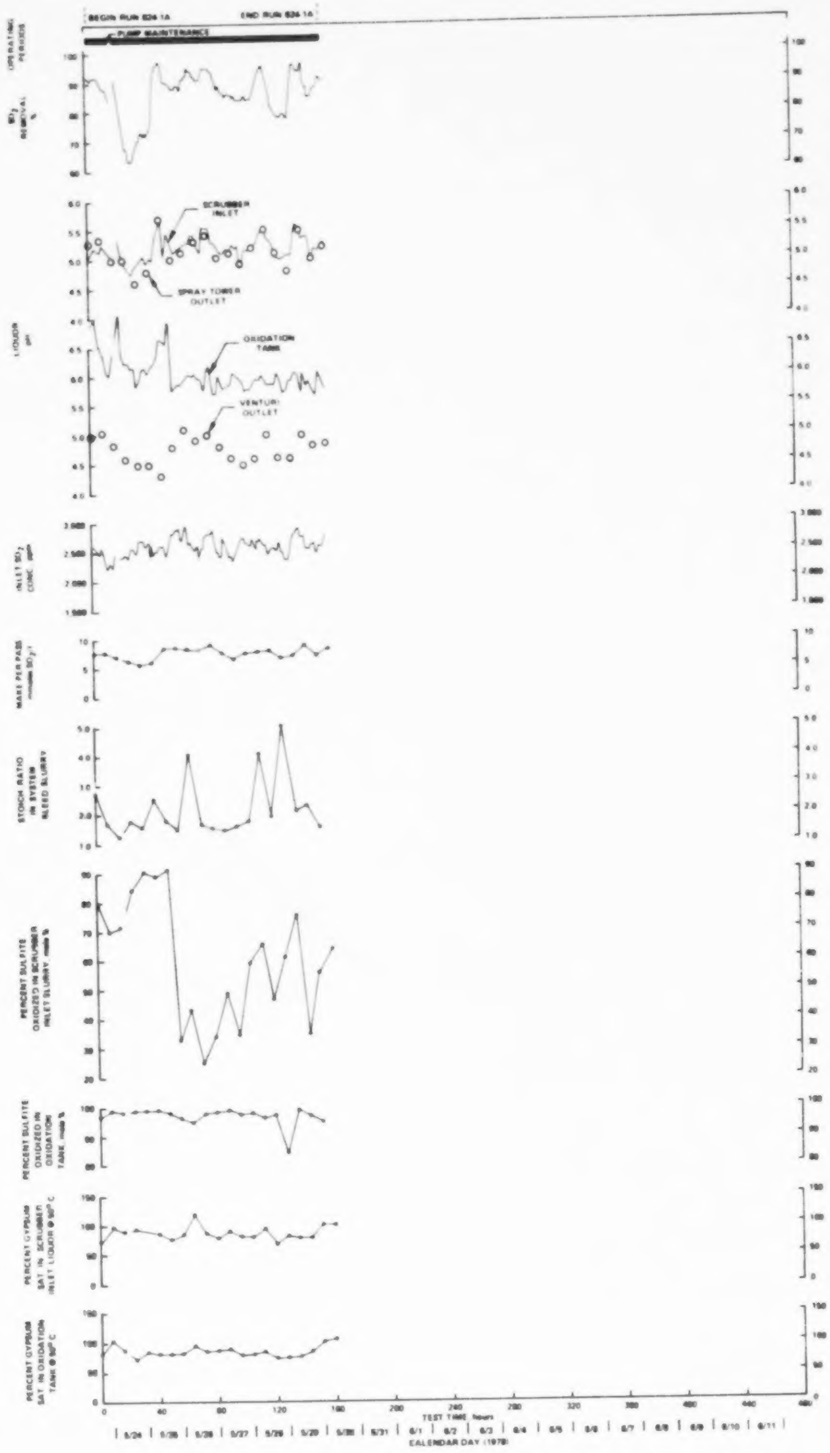
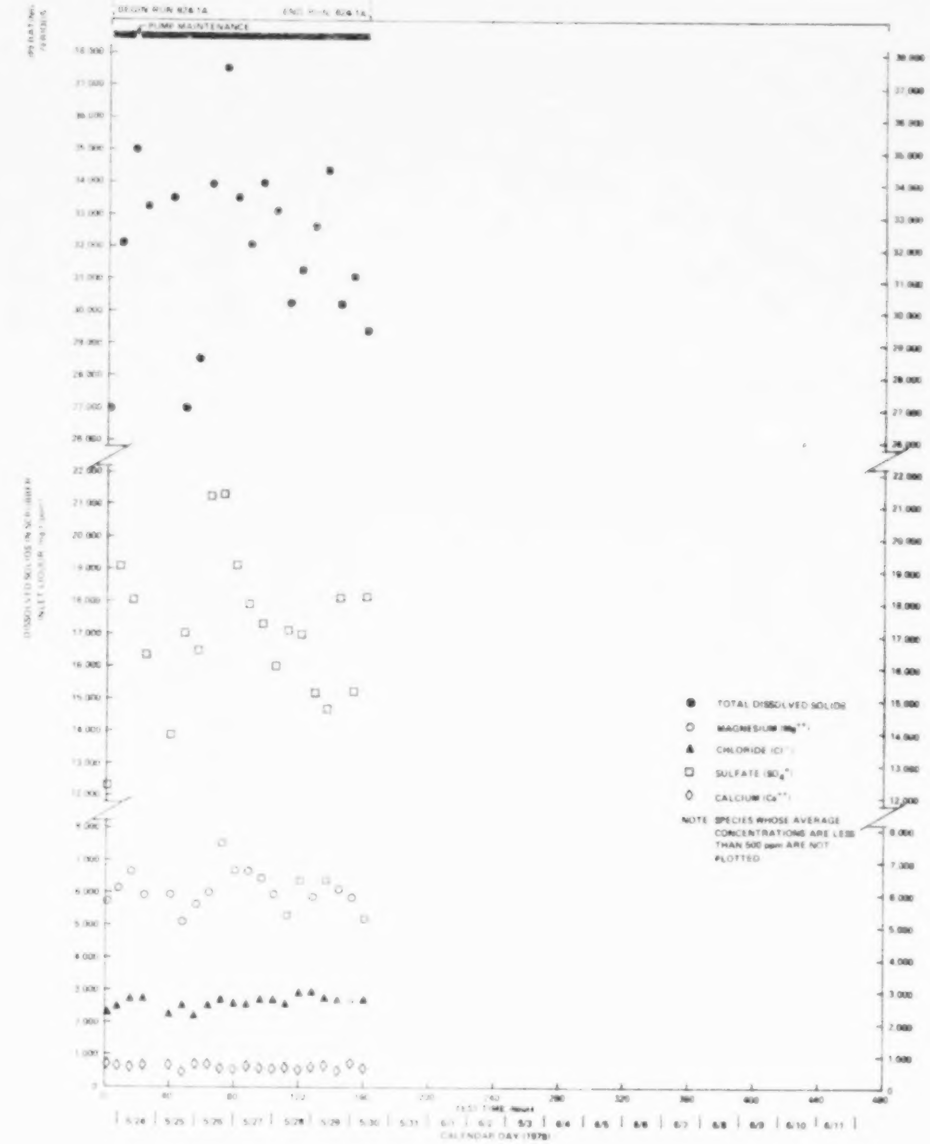


Figure F-24. OPERATING DATA FOR VENTURI/SPRAY TOWER RUN 824-1A



Gas Rate = 35,000 acfm @ 300° F
Spray Tower Gas Velocity = 9.4 ft/sec @ 125 ° F
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1500 gpm
Venturi L/G = 21 gal/Mcf
Spray Tower L/G = 57 gal/Mcf
No. of Spray Headers = 4
Effluent Hold Tank Residence Time = 11.2 min
Oxidation Tank Level = 18 ft
Percent Solids Recirculated = 12.9 - 15.3 wt %
Venturi Pressure Drop = 9 in. H_2O
Total Pressure Drop, Excl. Mist Elim.
= 14.6 - 17.6 in. H_2O
Mist Elim. Pressure Drop = 0.39 - 0.62 in. H_2O
Air Flow Rate to Oxidizer = 210 scfm
Discharge (Clarifier & Filter) Solids
Concentration = 80 - 90 wt %
Limestone & Dry MgO Addition to EHT
Clarified Liquor Returned to EHT
Recycle Slurry Flow from Oxidation Tank
to EHT - 30 gpm

Figure F-24 (continued). OPERATING DATA FOR VENTURI/SPRAY TOWER RUN 824-1A

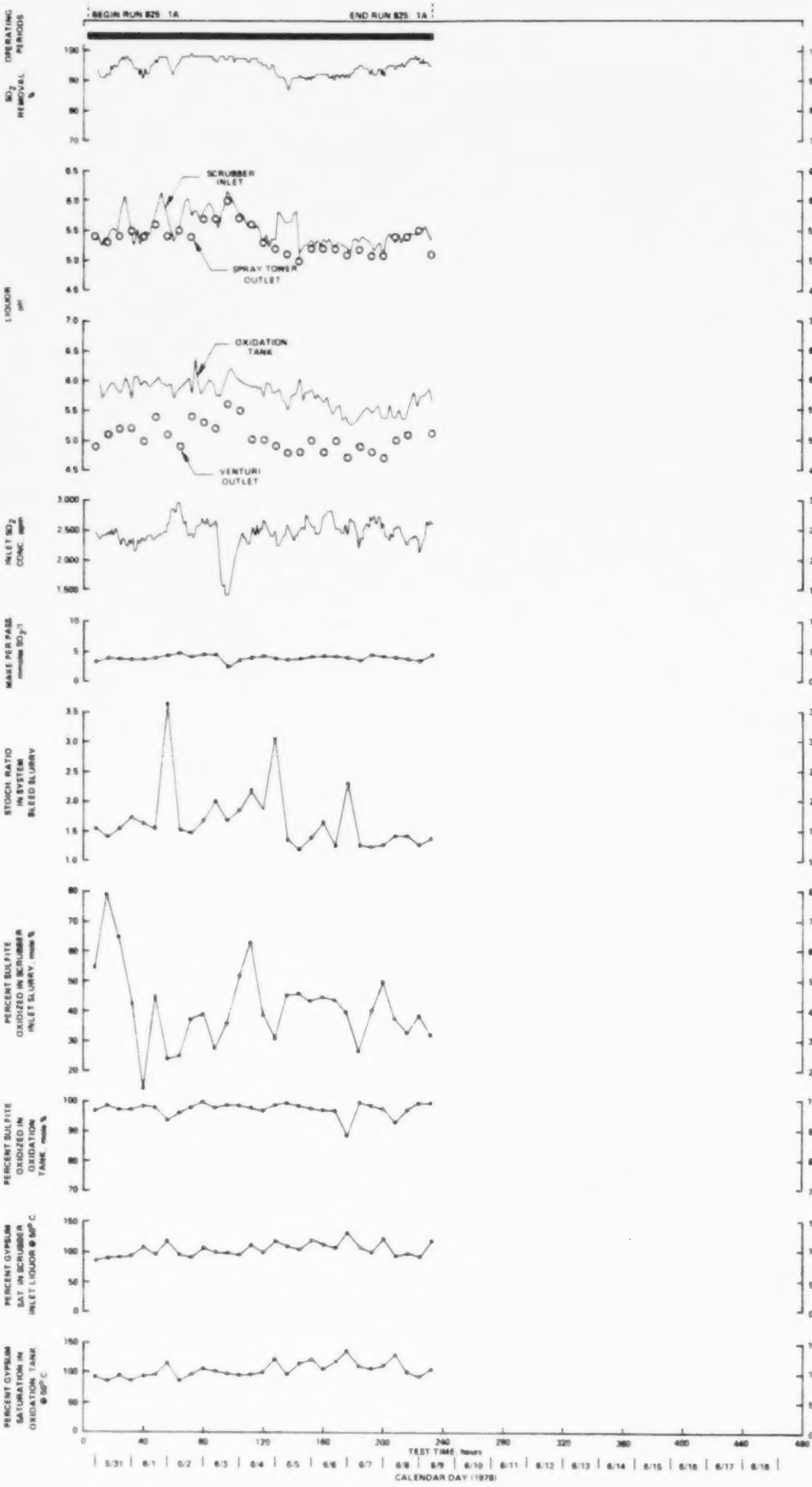
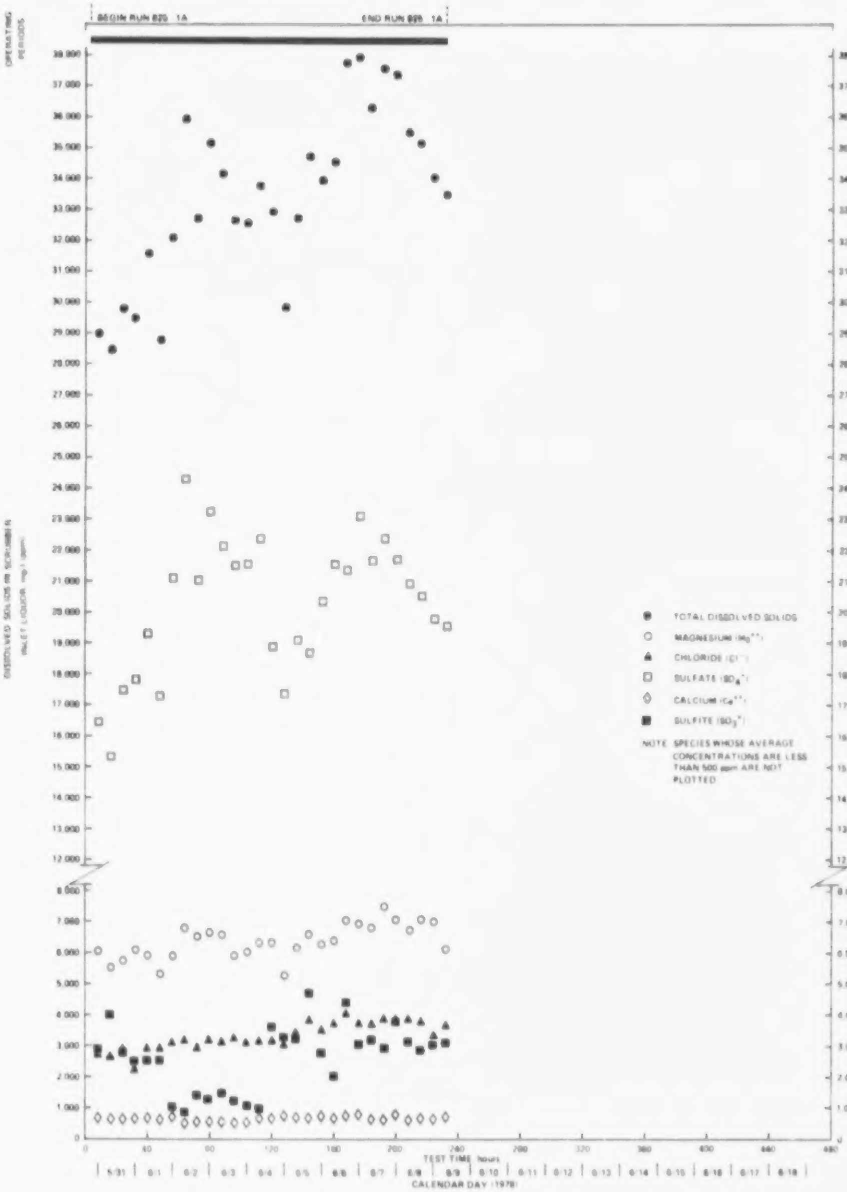


Figure F-25. OPERATING DATA FOR VENTURI/SPRAY TOWER RUN 825-1A



Gas Rate = 18,000 acfm @ 300° F
Spray Tower Gas Velocity = 4.8 ft/sec @ 125° F
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1600 gpm
Venturi L/G = 42 gal/Mcf
Spray Tower L/G = 111 gal/Mcf
No. of Spray Headers = 4
Effluent Hold Tank Residence Time = 11.2 min
Oxidation Tank Level = 18 ft
Percent Solids Recirculated = 13.4 - 16.0 wt %
Venturi Pressure Drop = 9 in. H_2O
Total Pressure Drop, Excl. Mist Elim.
= 10.0 - 13.7 in. H_2O
Mist Elim. Pressure Drop = 0.17 - 0.34 in. H_2O
Air Flow Rate to Oxidizer = 110 scfm
Discharge (Clarifier & Filter) Solids
Concentration = 82 - 88 wt %
Limestone & Dry MgO Addition to EHT
Clarified Liquor Returned to EHT
Recycle Slurry Flow from Oxidation Tank to EHT = 0

Figure F-25 (continued). OPERATING DATA FOR VENTURI/SPRAY TOWER RUN 825-1A

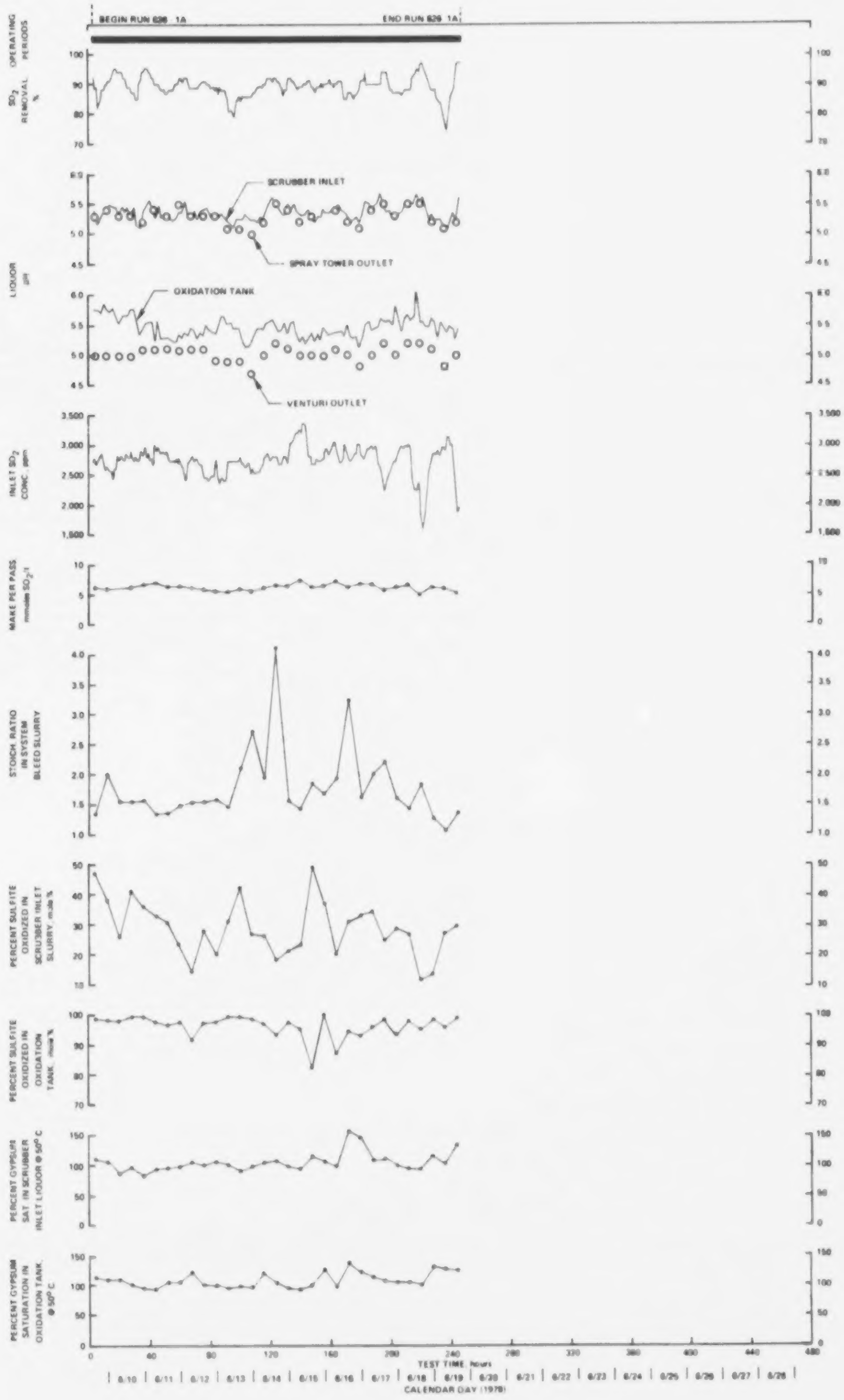
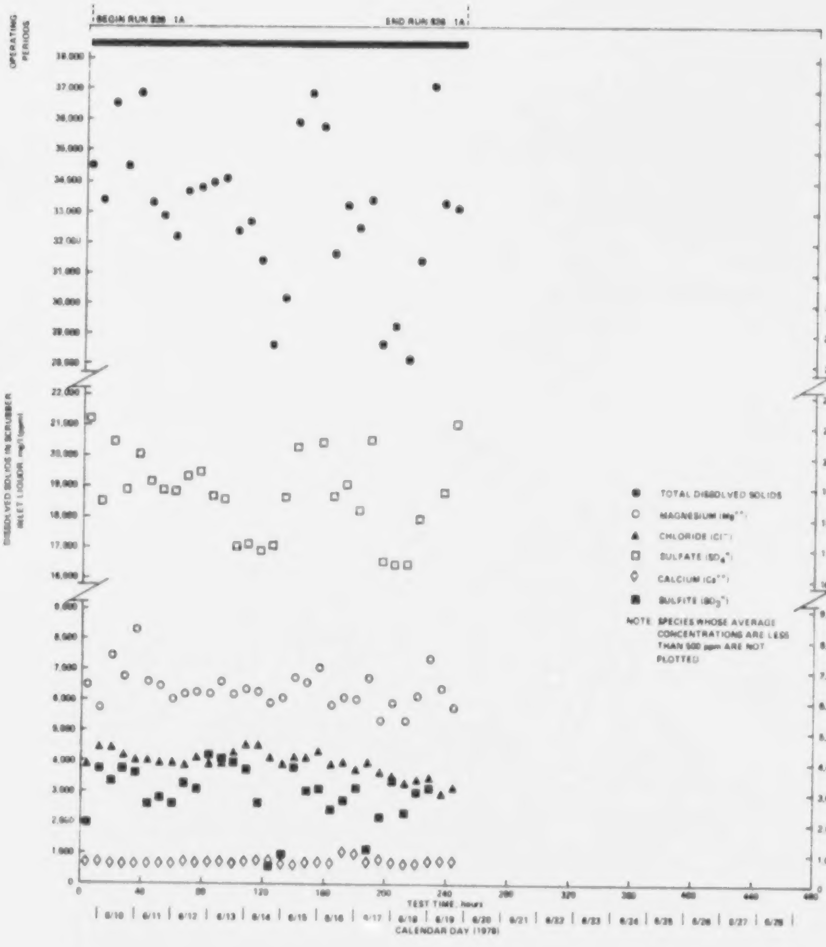
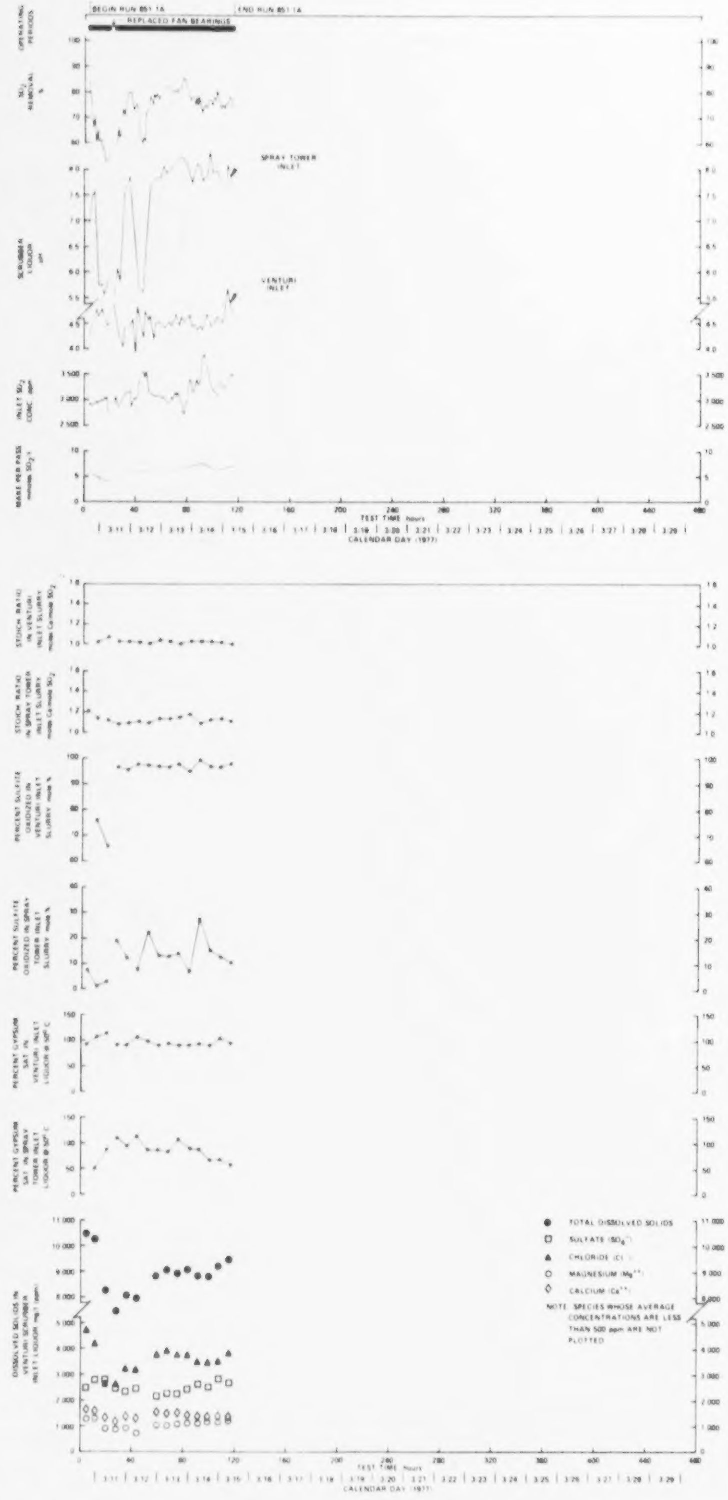


Figure F-26. OPERATING DATA FOR VENTURI/SPRAY TOWER RUN 826-1A



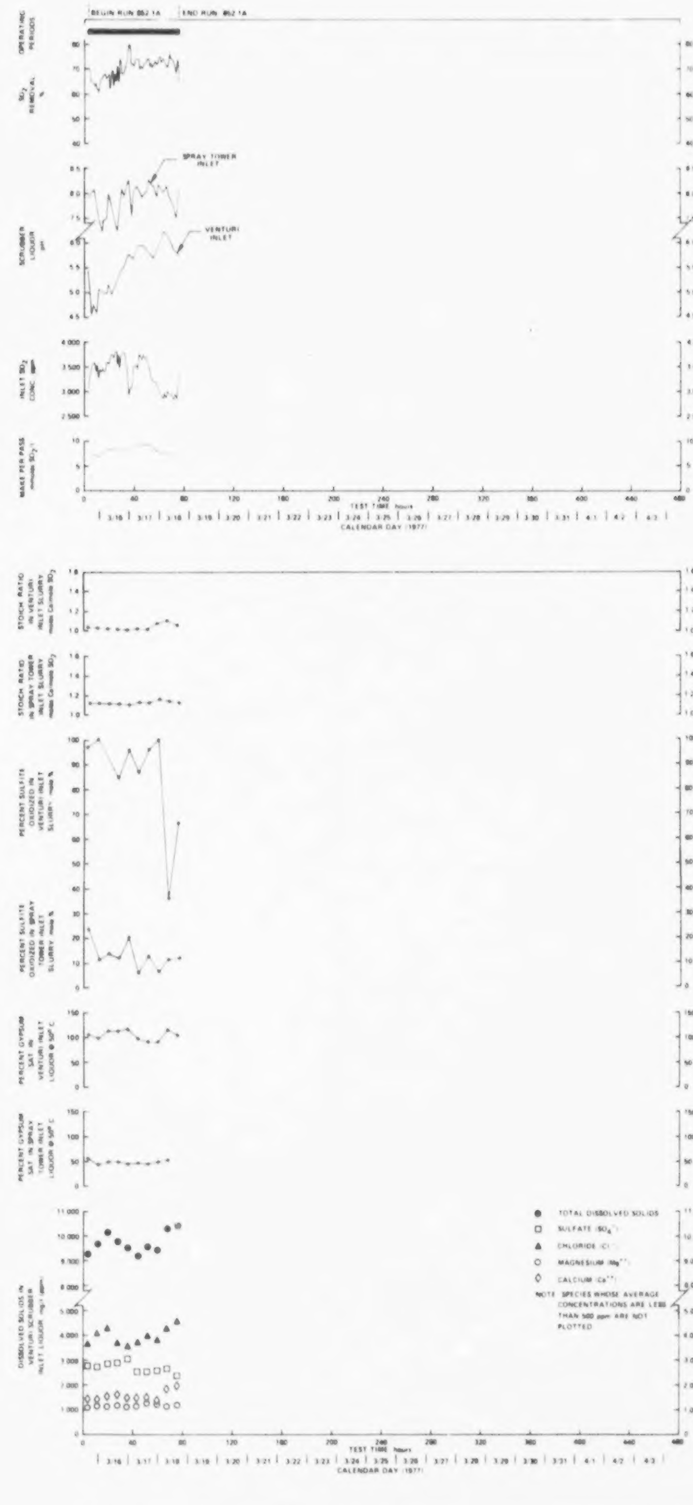
Gas Rate = 26,500 acfm @ 300° F
Spray Tower Gas Velocity = 7.1 ft/sec @ 125° F
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1600 gpm
Venturi L/G = 28 gal/Mcf
Spray Tower L/G = 75 gal/Mcf
No. of Spray Headers = 4
Effluent Hold Tank Residence Time = 11.2 min
Oxidation Tank Level = 18 ft
Percent Solids Recirculated = 14.6 - 15.8 wt %
Venturi Pressure Drop = 9 in. H_2O
Total Pressure Drop, Excl. Mist Elim.
= 12.2 - 14.4 in. H_2O
Mist Elim. Pressure Drop = 0.39 - 0.54 in. H_2O
Air Flow Rate to Oxidizer = 210 scfm
Discharge (Clarifier & Filter) Solids
Concentration = 80 - 88 wt %
Limestone and Dry MgO Addition to EHT
Clarified Liquor Returned to EHT
Recycle Slurry Flow from Oxidation Tank to EHT = 0

Figure F-26 (continued). OPERATING DATA FOR VENTURI/SPRAY TOWER RUN 826-1A



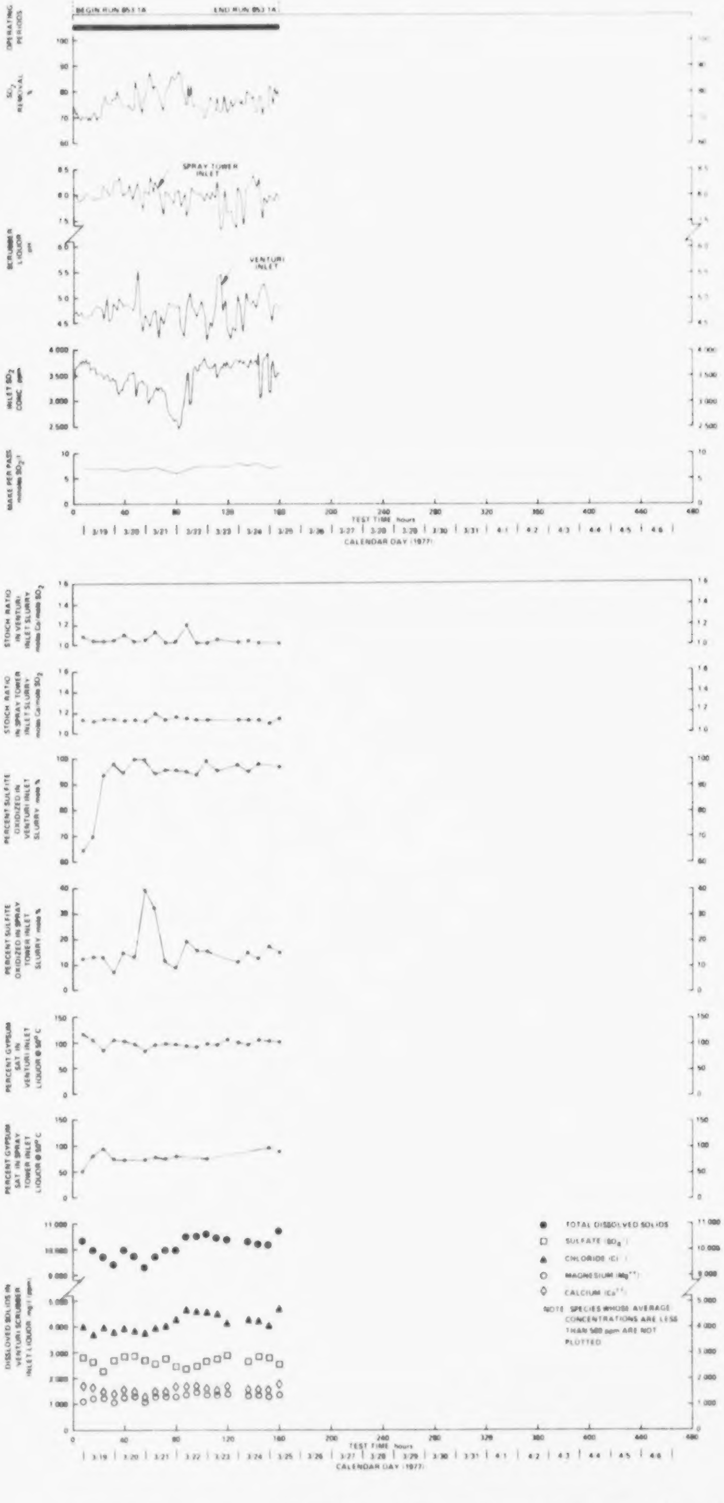
Gas Rate = 25,000 acfm @ 300° F
Spray Tower Gas Velocity = 6.7 ft/sec
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1400 gpm
Venturi L/G = 30 gal/Mcf
Spray Tower L/G = 70 gal/Mcf
No. of Spray Headers = 4
Residence Times
  Spray Tower Hold Tank = 18 min
  Oxidation Tank = 11.3 min
  Desupersaturation Tank = 4.7 min
Solids Recirculated, Venturi Loop = 13.9-16.5 wt %
Solids Recirculated, Spray Tower Loop = 5.6-6.3 wt %
Venturi Pressure Drop = 9 in. H_2O
Total Pressure Drop, Excl. Mist Elim.
  = 10.3-11.2 in. H_2O
Mist Elim. Pressure Drop = 0.24-0.30 in. H_2O
Air Flow Rate to Oxidizer = 150 scfm
Discharge (Clarifier & Filter) Solids
  Concentration = 74-88 wt %
Lime Addition to Venturi Downcomer & Spray Tower EHT
Clarified Liquor Returned to Oxidation Tank & Spray Tower EHT

Figure F-27. OPERATING DATA FOR VENTURI/SPRAY TOWER RUN 851-1A



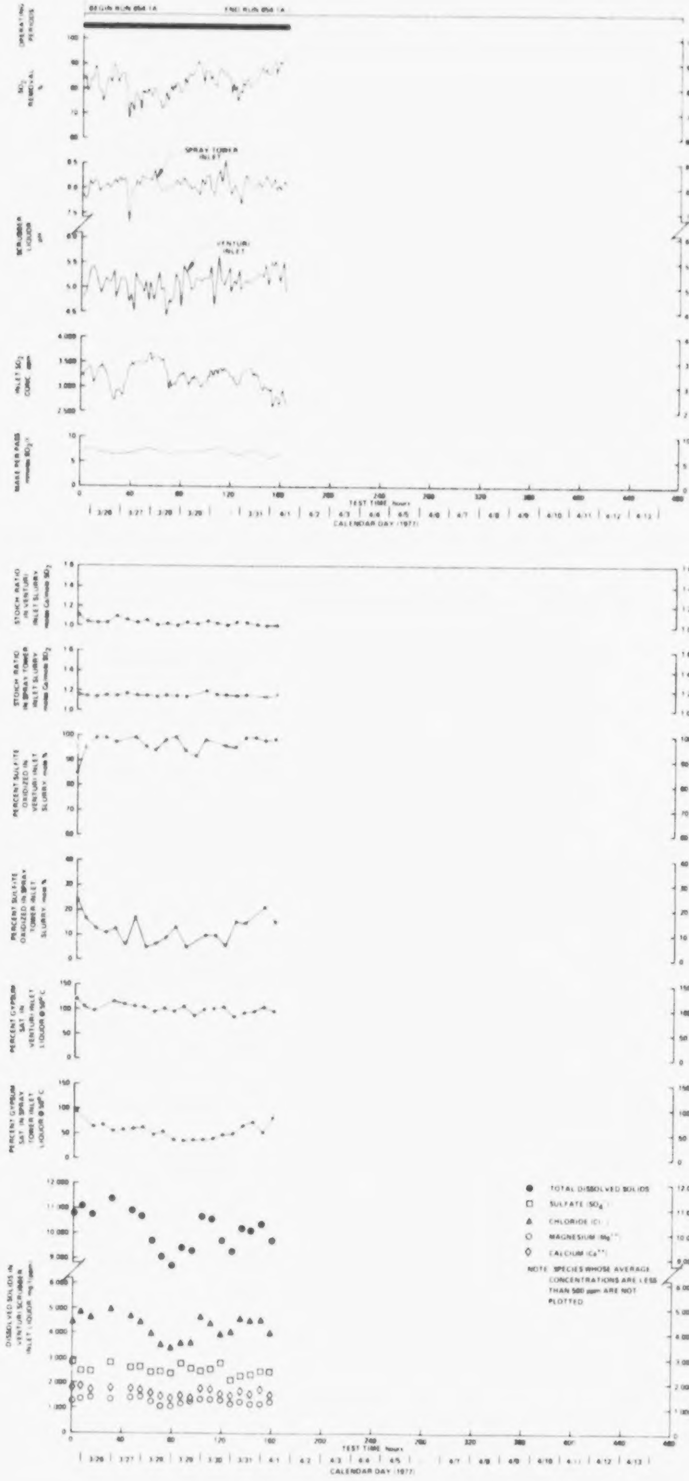
Gas Rate = 25,000 acfm @ 300° F
Spray Tower Gas Velocity = 6.7 ft/sec
Liquor Rate to Venturi = 160 gpm
Liquor Rate to Spray Tower = 1400 gpm
Venturi L/G = 8 gal/Mcf
Spray Tower L/G = 70 gal/Mcf
No. of Spray Headers = 4
Residence Times
  Spray Tower Hold Tank = 18 min
  Oxidation Tank = 42 min
  Desupersaturation Tank = 17.7 min
Solids Recirculated, Venturi Loop = 14.6-17.8 wt %
Solids Recirculated, Spray Tower Loop = 6.4-10.1 wt %
Venturi Pressure Drop = 1.7-3.5 in. H_2O (Plug 100% Open)
Total Pressure Drop, Excl. Mist Elim.
  = 3.3-4.7 in. H_2O
Mist Elim. Pressure Drop = 0.23-0.29 in. H_2O
Air Flow Rate to Oxidizer = 150 scfm
Discharge (Clarifier & Filter) Solids
  Concentration = 65-80 wt %
Lime Addition to Venturi Downcomer & Spray Tower EHT
Clarified Liquor Returned to Oxidation Tank & Spray Tower EHT

Figure F-28. OPERATING DATA FOR VENTURI/SPRAY TOWER RUN 852-1A



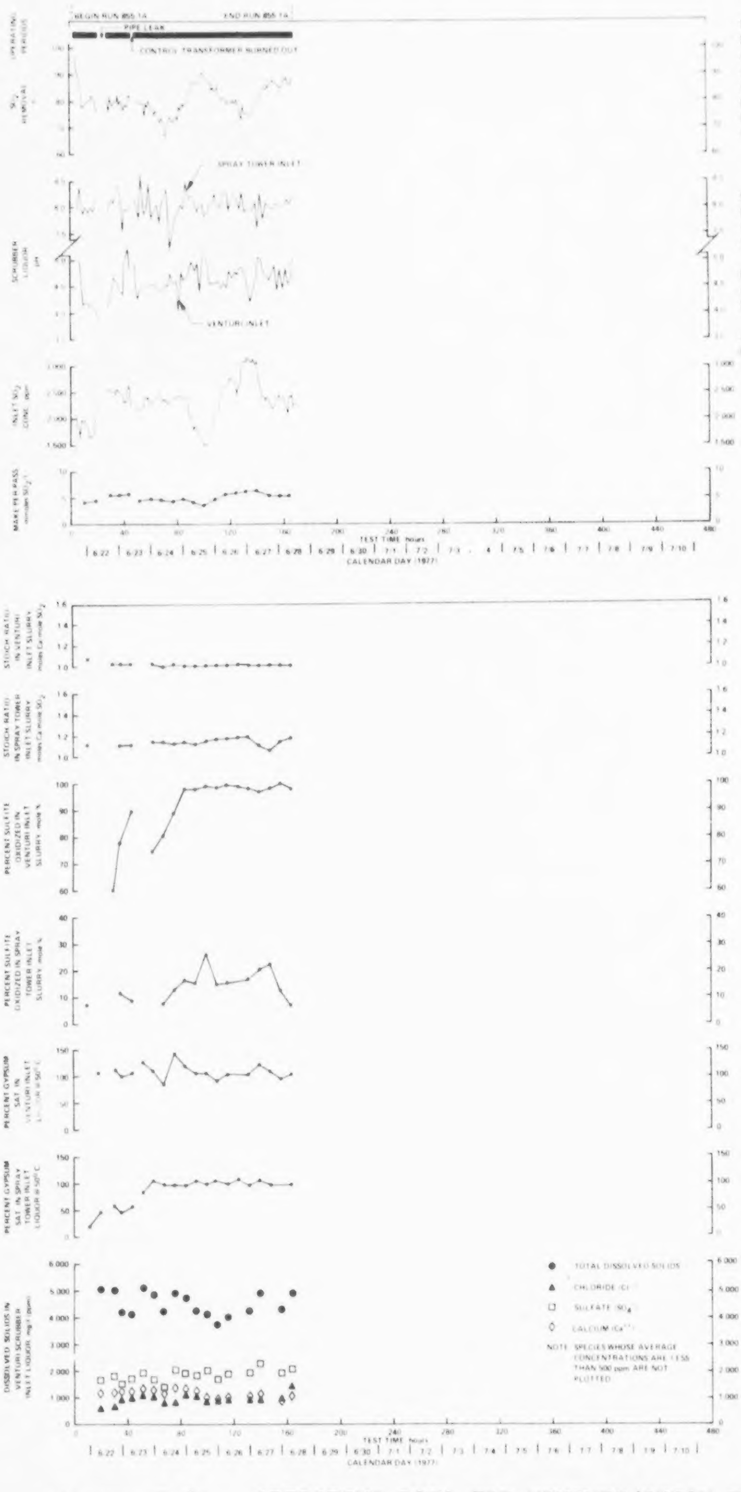
Gas Rate = 25,000 acfm @ 300° F
Spray Tower Gas Velocity = 6.7 ft/sec
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1400 gpm
Venturi L/G = 30 gal/Mcf
Spray Tower L/G = 70 gal/Mcf
No. of Spray Headers = 4
Residence Times
  Spray Tower Hold Tank = 18 min
  Oxidation Tank = 11.3 min
  Desupersaturation Tank = 4.7 min
Solids Recirculated, Venturi Loop = 13.9-16.5 wt %
Solids Recirculated, Spray Tower Loop = 5.9-6.9 wt %
Venturi Pressure Drop = 4.4-5.0 in. H_2O (Plug 100% Open)
Total Pressure Drop, Excl. Mist Elim.
  = 6.1-7.0 in. H_2O
Mist Elim. Pressure Drop = 0.24-0.30 in. H_2O
Air Flow Rate to Oxidizer = 150 scfm
Discharge (Clarifier & Filter) Solids
  Concentration = 73-83 wt %
Lime Addition to Venturi Downcomer & Spray Tower EHT
Clarified Liquor Returned to Spray Tower EHT

Figure F-29. OPERATING DATA FOR VENTURI/SPRAY TOWER RUN 853-1A



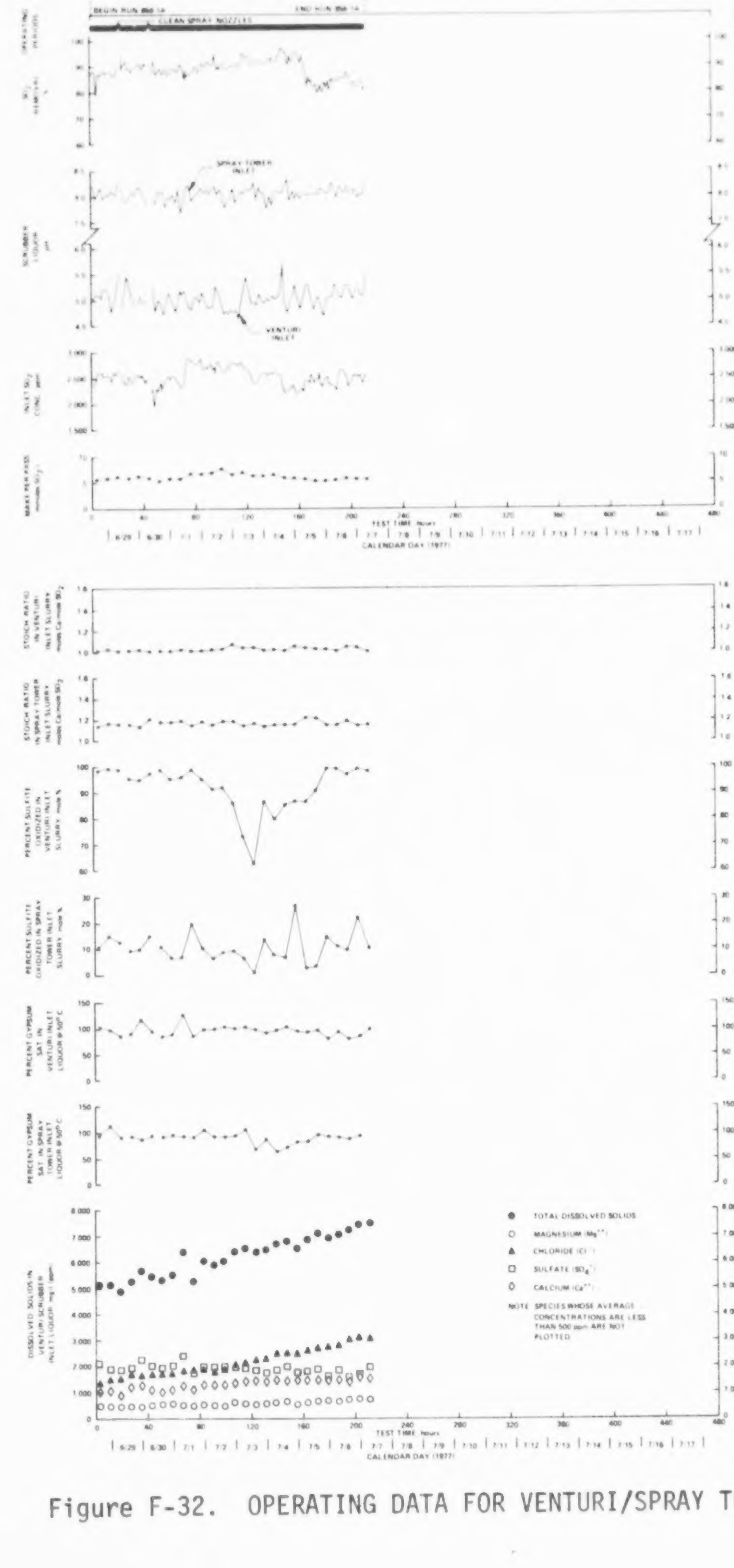
Gas Rate = 25,000 acfm @ 300° F
Spray Tower Gas Velocity = 6.7 ft/sec
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1400 gpm
Venturi L/G = 30 gal/Mcf
Spray Tower L/G = 70 gal/Mcf
No. of Spray Headers = 4
Residence Times
  Spray Tower Hold Tank = 18 min
  Oxidation Tank = 11.3 min
  Desupersaturation Tank = 4.7 min
Solids Recirculated, Venturi Loop = 13.8-16.6 wt %
Solids Recirculated, Spray Tower Loop = 5.5-6.7 wt %
Venturi Pressure Drop = 9 in. H_2O
Total Pressure Drop, Excl. Mist Elim.
  = 10.2-11.2 in. H_2O
Mist Elim. Pressure Drop = 0.24-0.30 in. H_2O
Air Flow Rate to Oxidizer = 150 scfm
Discharge (Clarifier & Filter) Solids
  Concentration = 75-83 wt %
Lime Addition to Venturi Downcomer & Spray Tower EHT
Clarified Liquor Returned to Spray Tower EHT

Figure F-30. OPERATING DATA FOR VENTURI/SPRAY TOWER RUN 854-1A



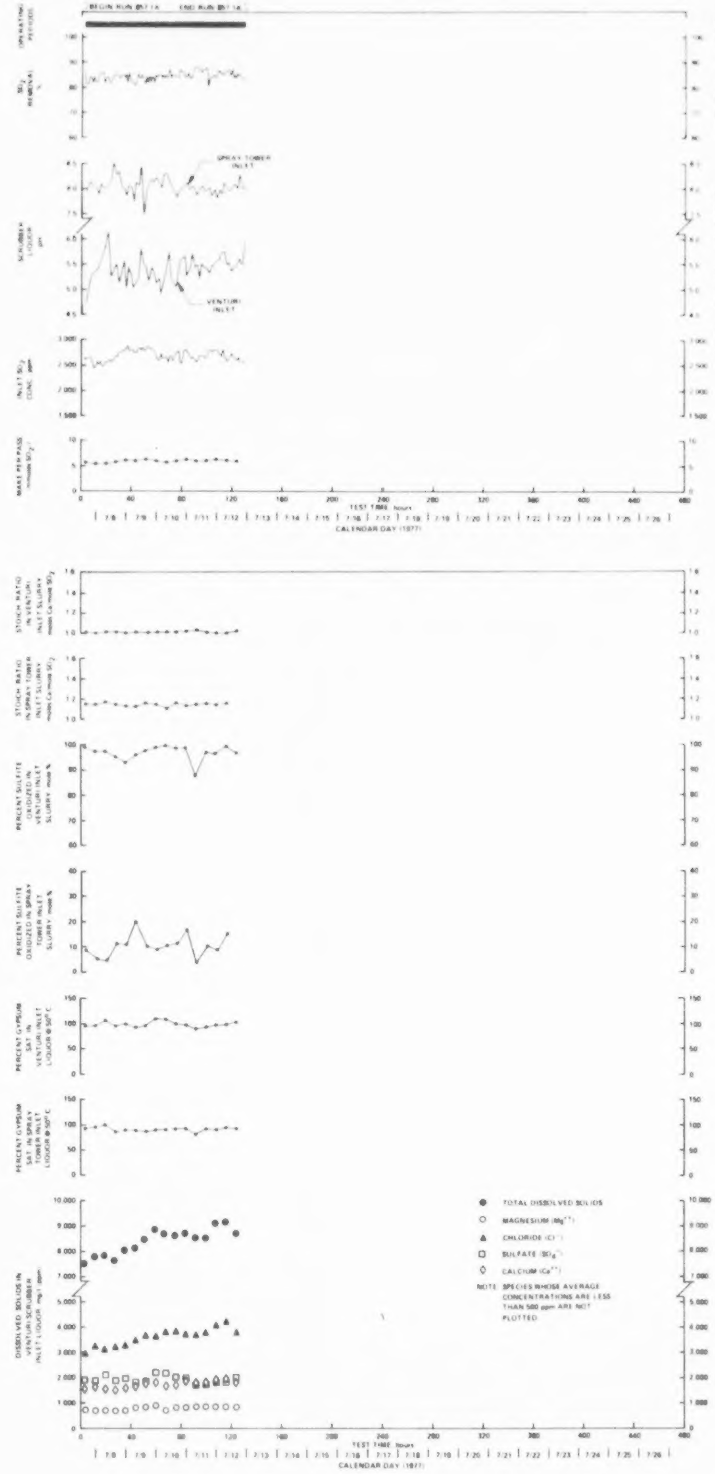
Gas Rate = 25,000 acfm @ 300° F
Spray Tower Gas Velocity = 6.7 ft/sec
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1400 gpm
Venturi L/G = 30 gal/Mcf
Spray Tower L/G = 70 gal/Mcf
No. of Spray Headers = 4
Residence Time:
    Spray Tower Hold Tank = 18 min
    Oxidation Tank = 11.3 min
    Desupersaturation Tank = 4.7 min
Solids Recirculated, Venturi Loop = 12.9-16.4 wt %
Solids Recirculated, Spray Tower Loop = 6.8-7.7 wt %
Venturi Pressure Drop = 9 in. H_2O
Total Pressure Drop, Excl. Mist Elim.
    = 11.6-12.2 in. H_2O
Mist Elim. Pressure Drop = 0.32-0.36 in. H_2O
Air Flow Rate to Oxidizer = 150 scfm
Discharge (Clarifier & Filter) Solids
    Concentration = 62-88 wt %
Lime Addition to Venturi Downcomer & Spray Tower EHT
Clarified Liquor Returned to Spray Tower EHT

Figure F-31. OPERATING DATA FOR VENTURI/SPRAY TOWER RUN 855-1A



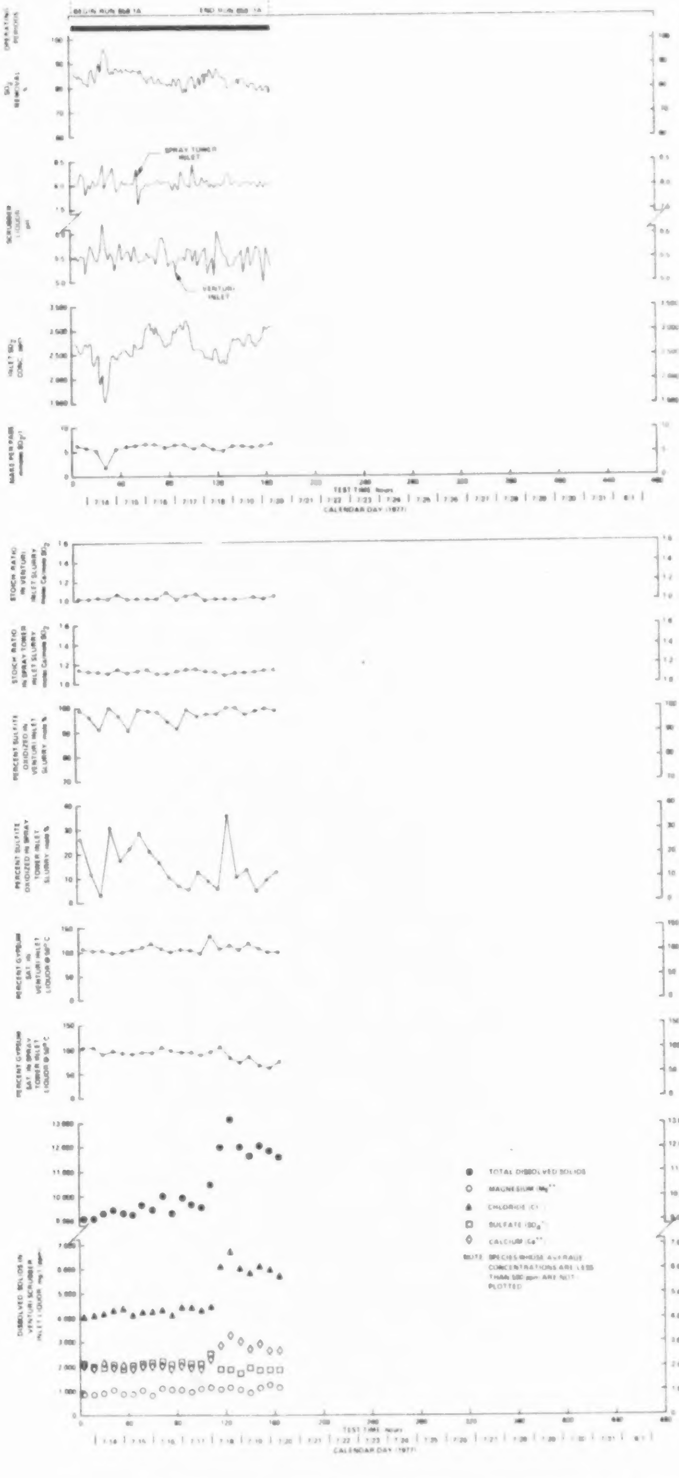
Gas Rate = 25,000 acfm @ 300 °F
Spray Tower Gas Velocity = 6.7 ft/sec
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1400 gpm
Venturi L/G = 30 gal/Mcf
Spray Tower L/G = 70 gal/Mcf
No. of Spray Headers = 4
Residence Times
  Spray Tower Hold Tank = 18 min
  Oxidation Tank = 11.3 min
  Desupersaturation Tank = 4.7 min
Solids Recirculated, Venturi Loop = 14.2-16.4 wt %
Solids Recirculated, Spray Tower Loop = 7.5-8.2 wt %
Venturi Pressure Drop = 9 in. H_2O
Total Pressure Drop, Excl. Mist Elim.
  = 11.5-12.7 in. H_2O
Mist Elim. Pressure Drop = 0.31-0.36 in. H_2O
Air Flow Rate to Oxidizer = 150 scfm
Discharge (Clarifier and Filter) Solids
  Concentration = 75-90 wt %
Lime Addition to Venturi Downcomer & Spray Tower EHT
Clarified Liquor Returned to Spray Tower EHT

Figure F-32. OPERATING DATA FOR VENTURI/SPRAY TOWER RUN 856-1A



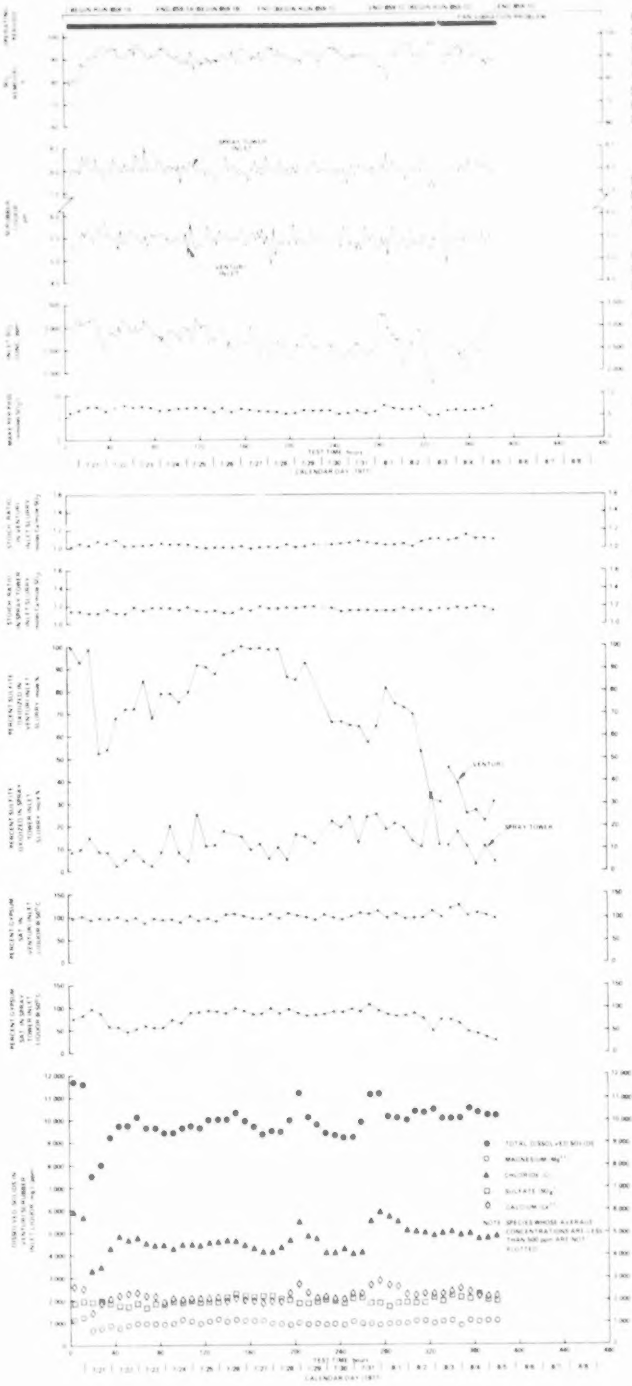
Gas Rate = 25,000 acfm @ 300 °F
Spray Tower Gas Velocity = 6.7 ft/sec
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1400 gpm
Venturi L/G = 30 gal/Mcf
Spray Tower L/G = 70 gal/Mcf
No. of Spray Headers = 4
Residence Times:
  Spray Tower Hold Tank = 18 min
  Oxidation Tank = 11.3 min
  Desupersaturation Tank = 4.7 min
Solids Recirculated, Venturi Loop = 13.4-16.2 wt %
Solids Recirculated, Spray Tower Loop = 7.3-8.4 wt %
Venturi Pressure Drop = 9 in. H_2O
Total Pressure Drop, Excl. Mist Elim.
  = 11.4-12.0 in. H_2O
Mist Elim. Pressure Drop = 0.31-0.35 in. H_2O
Air Flow Rate to Oxidizer = 150 scfm
Discharge (Clarifier and Filter) Solids
  Concentration = 70-86 wt %
Lime Addition to Venturi Downcomer & Spray Tower EHT
Clarified Liquor Returned to Spray Tower EHT

Figure F-33. OPERATING DATA FOR VENTURI/SPRAY TOWER RUN 857-1A



Gas Rate = 25,000 acfm @ 300 °F
Spray Tower Gas Velocity = 6.7 ft/sec
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1400 gpm
Venturi L/G = 30 gal/Mcf
Spray Tower L/G = 70 gal/Mcf
No. of Spray Headers = 4
Residence Times:
  Spray Tower Hold Tank = 18 min
  Oxidation Tank = 11.3 min
  Desupersaturation Tank = 4.7 min
Solids Recirculated, Venturi Loop = 6.8-8.6 wt %
Solids Recirculated, Spray Tower Loop = 13.9-16.5 wt %
Venturi Pressure Drop = 9 in. H_2O
Total Pressure Drop, Excl. Mist Elim.
  = 11.4-11.6 in. H_2O
Mist Elim. Pressure Drop = 0.31-0.35 in. H_2O
Air Flow Rate to Oxidizer = 150 acfm
Discharge (Clarifier and Filter) Solids
  Concentration = 72-80 wt %
Lime Addition to Venturi Downcomer & Spray Tower EHT
Clarified Liquor Returned to Oxidation Tank

Figure F-34. OPERATING DATA FOR VENTURI/SPRAY TOWER RUN 858-1A



Gas Rate = 25,000 acfm @ 300 °F
Spray Tower Gas Velocity = 6.7 ft/sec
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1400 gpm
Venturi L/G = 30 gal/Mcf
Spray Tower L/G = 70 gal/Mcf
No. of Spray Headers = 4
Residence Times
  Spray Tower Hold Tank = 18 min
  Oxidation Tank = 11.3 min
  Desupersaturation Tank = 4.7 min
Solids Recirculated, Venturi Loop = 12.6-16.2 wt %
Solids Recirculated, Spray Tower Loop = 6.6-7.8 wt %
Venturi Pressure Drop = 9 in. H_2O
Total Pressure Drop, Excl. Mist Elim.
  = 11.5-12.9 in. H_2O
Mist Elim. Pressure Drop = 0.28-0.34 in. H_2O
Clarified Liquor Returned to Spray Tower EHT
Lime Addition to Venturi Downcomer & Spray Tower EHT

RUN 859 - 1A

Air Flow Rate to Oxidizer = 135 scfm
Discharge (Clarifier and Filter) Solids
  Concentration = 64.83 wt %

RUN 859 - 1B

Air Flow Rate to Oxidizer = 150 scfm
Discharge (Clarifier and Filter) Solids
  Concentration = 69.86 wt %

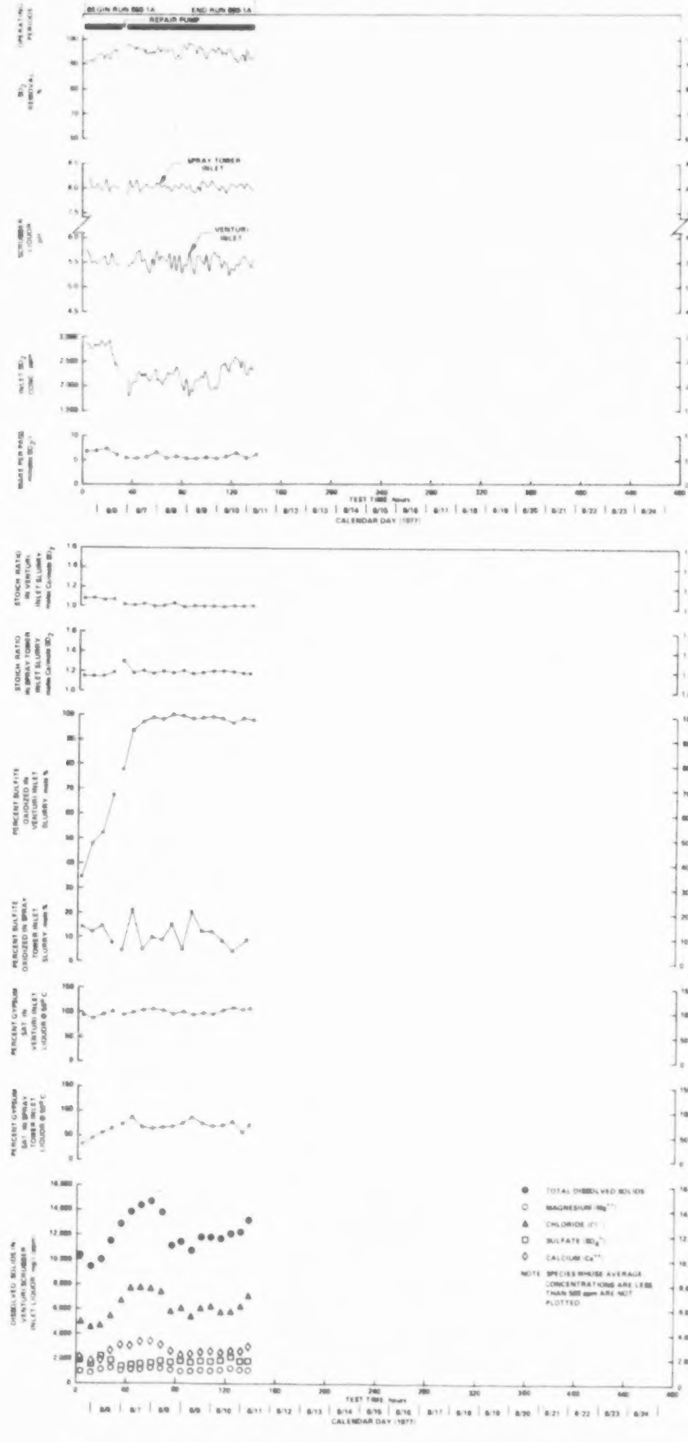
RUN 859 - 1C

Air Flow Rate to Oxidizer = 100 scfm
Discharge (Clarifier and Filter) Solids
  Concentration = 64.77 wt %

RUN 859 - 1D

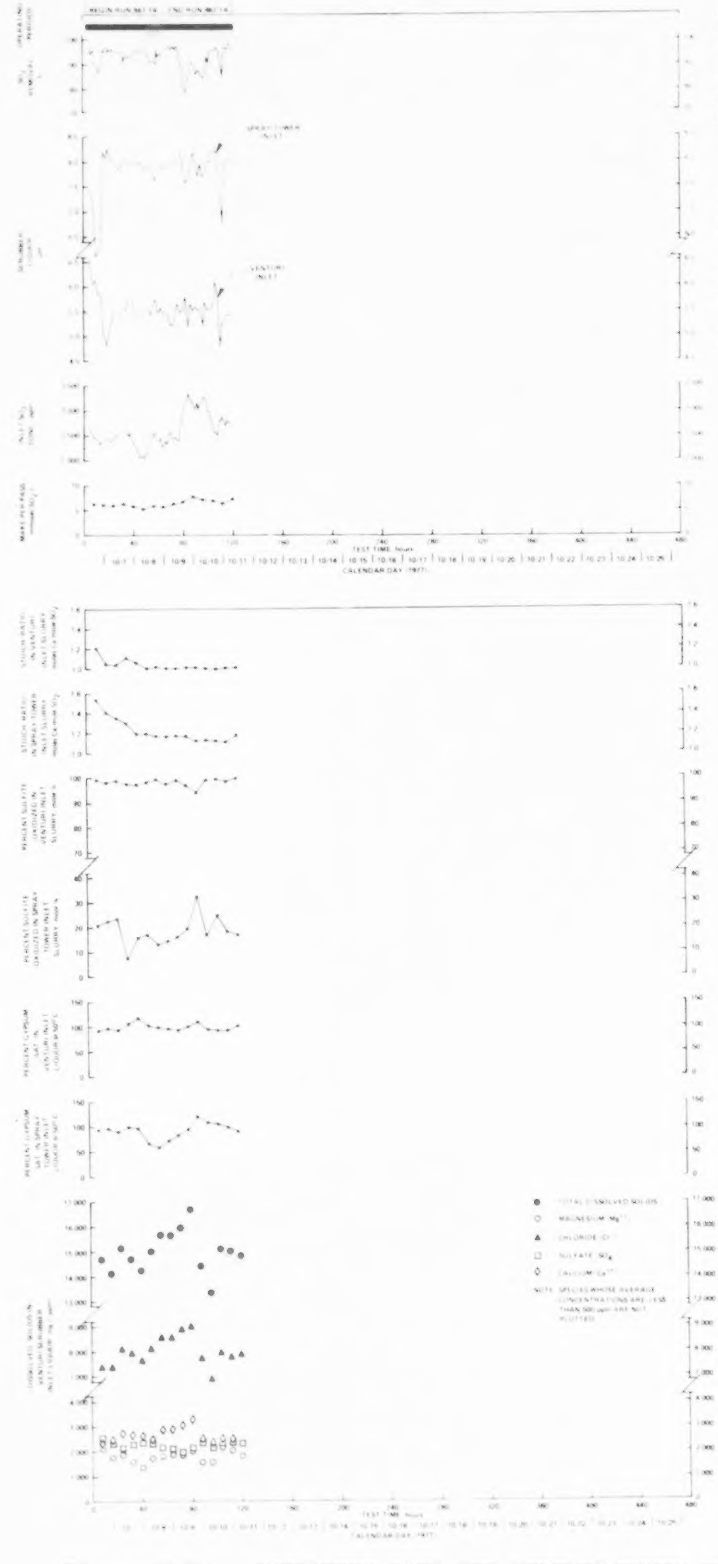
Air Flow Rate to Oxidizer = 0 scfm
Discharge (Clarifier and Filter) Solids
  Concentration = 52.57 wt %

Figure F-35. OPERATING DATA FOR VENTURI/SPRAY TOWER RUNS 859-1A, 859-1B, 859-1C, & 859-1D



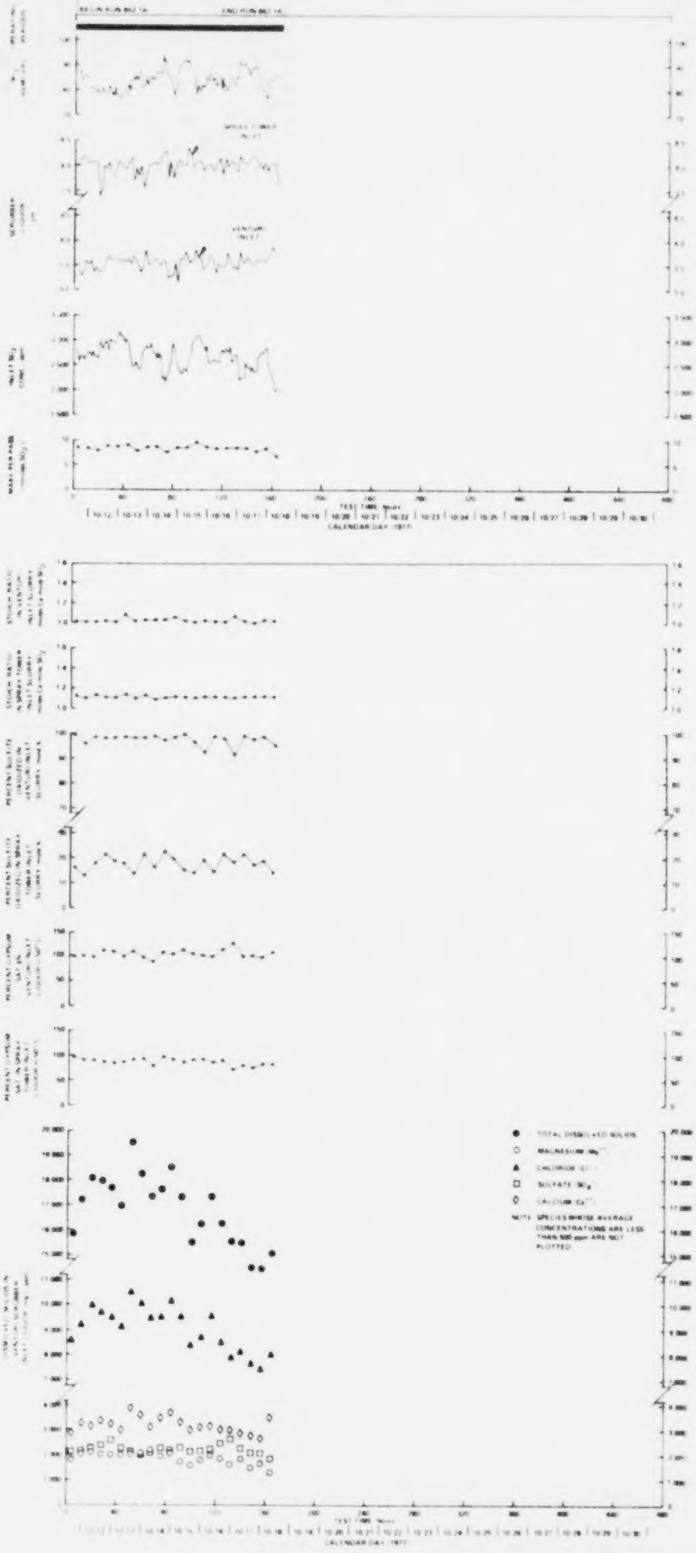
Gas Rate = 25,000 acfm @ 300° F
Spray Tower Gas Velocity = 6.7 ft/sec
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1400 gpm
Venturi L/G = 30 gal/Mcf
Spray Tower L/G = 70 gal/Mcf
No. of Spray Headers = 4
Residence Times
  Spray Tower Hold Tank = 12.6 min
  Oxidation Tank = 11.3 min
  Desupersaturation Tank = 4.7 min
Solids Recirculated, Venturi Loop = 12.4-16.5 wt %
Solids Recirculated, Spray Tower Loop = 6.3-7.7 wt %
Venturi Pressure Drop = 9 in. H_2O
Total Pressure Drop, Excl. Mist Elim.
  = 11.5-12.2 in. H_2O
Mist Elim. Pressure Drop = 0.30-0.33 in. H_2O
Air Flow Rate to Oxidizer = 150 acfm
Discharge (Clarifier & Filter) Solids
  Concentration = 74-89 wt %
Lime Addition to Venturi Downcomer & Spray Tower EHT
Clarified Liquor Returned to Spray Tower EHT

Figure F-36. OPERATING DATA FOR VENTURI/SPRAY TOWER RUN 860-1A



Gas Rate = 25,000 acfm @ 300° F
Spray Tower Gas Velocity = 6.7 ft/sec
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1400 gpm
Venturi L/G = 30 gal/Mcf
Spray Tower L/G = 70 gal/Mcf
No. of Spray Headers = 4
Residence Times
  Spray Tower Hold Tank = 18 min
  Oxidation Tank = 11.3 min
  Desupersaturation Tank = 4.7 min
Solids Recirculated: Venturi Loop = 13.4-14.9 wt %
Solids Recirculated: Spray Tower Loop = 7.0-7.5 wt %
Venturi Pressure Drop = 9 in. H_2O
Total Pressure Drop, Excl. Mist Elim.
  = 10.9-13.5 in. H_2O
Mist Elim. Pressure Drop = 0.27-0.32 in. H_2O
Air Flow Rate to Oxidizer = 150 scfm
Discharge (Clarifier & Filter) Solids
  Concentration = 82-90 wt %
Lime Addition to Venturi Downcomer & Spray Tower EHT
Clarified Liquor Returned to Spray Tower EHT

Figure F-37. OPERATING DATA FOR VENTURI/SPRAY TOWER RUN 861-1A



Gas Rate = 35,000 acfm @ 300° F
Spray Tower Gas Velocity = 9.4 ft/sec
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1400 gpm
Venturi L/G = 21 gal/Mcf
Spray Tower L/G = 50 gal/Mcf
No. of Spray Headers = 4
Residence Times:
    Spray Tower Hold Tank = 18 min
    Oxidation Tank = 11.3 min
    Desupersaturation Tank = 4.7 min
Solids Recirculated, Venturi Loop = 14.3-15.6 wt %
Solids Recirculated, Spray Tower Loop = 15.5-19.1 wt %
Venturi Pressure Drop = 9 in. H_2O
Total Pressure Drop, Excl. Mist Elim.
    = 14.5-16.2 in. H_2O
Mist Elim. Pressure Drop = 0.56-0.64 in. H_2O
Air Flow Rate to Oxidizer = 210 scfm
Discharge (Clarifier & Filter) Solids
    Concentration = 82-88 wt %
Lime Addition to Venturi Downcomer & Spray Tower EHT
Clarified Liquor Returned to Oxidation Tank

Figure F-38. OPERATING DATA FOR VENTURI/SPRAY TOWER RUN 862-1A

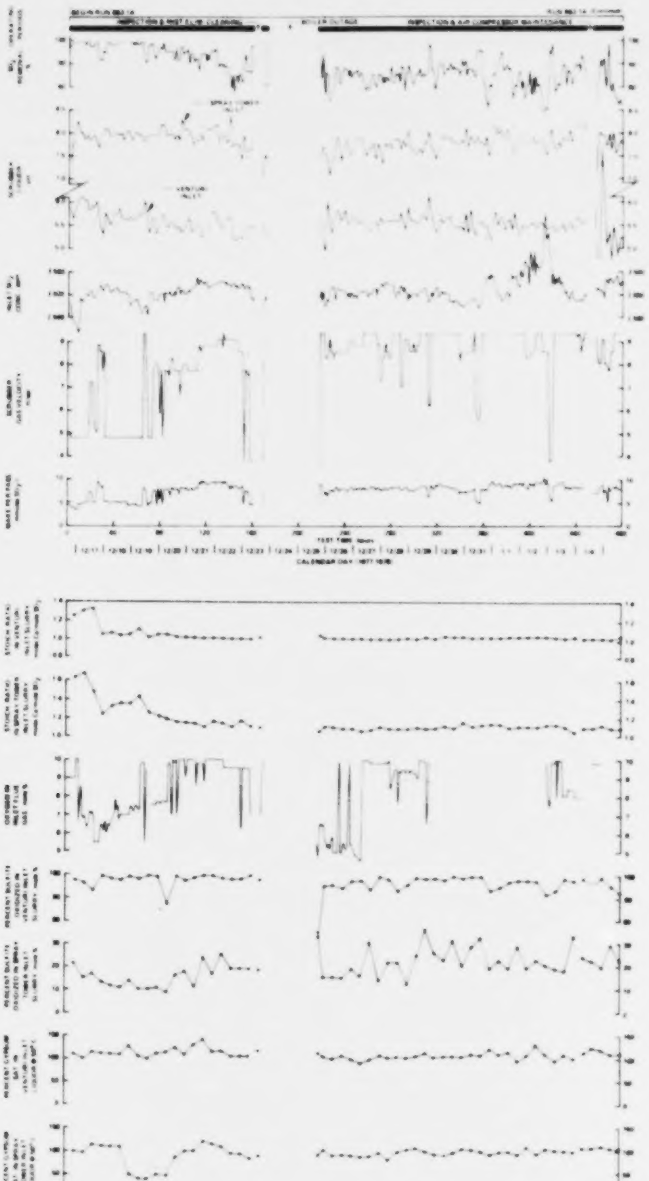
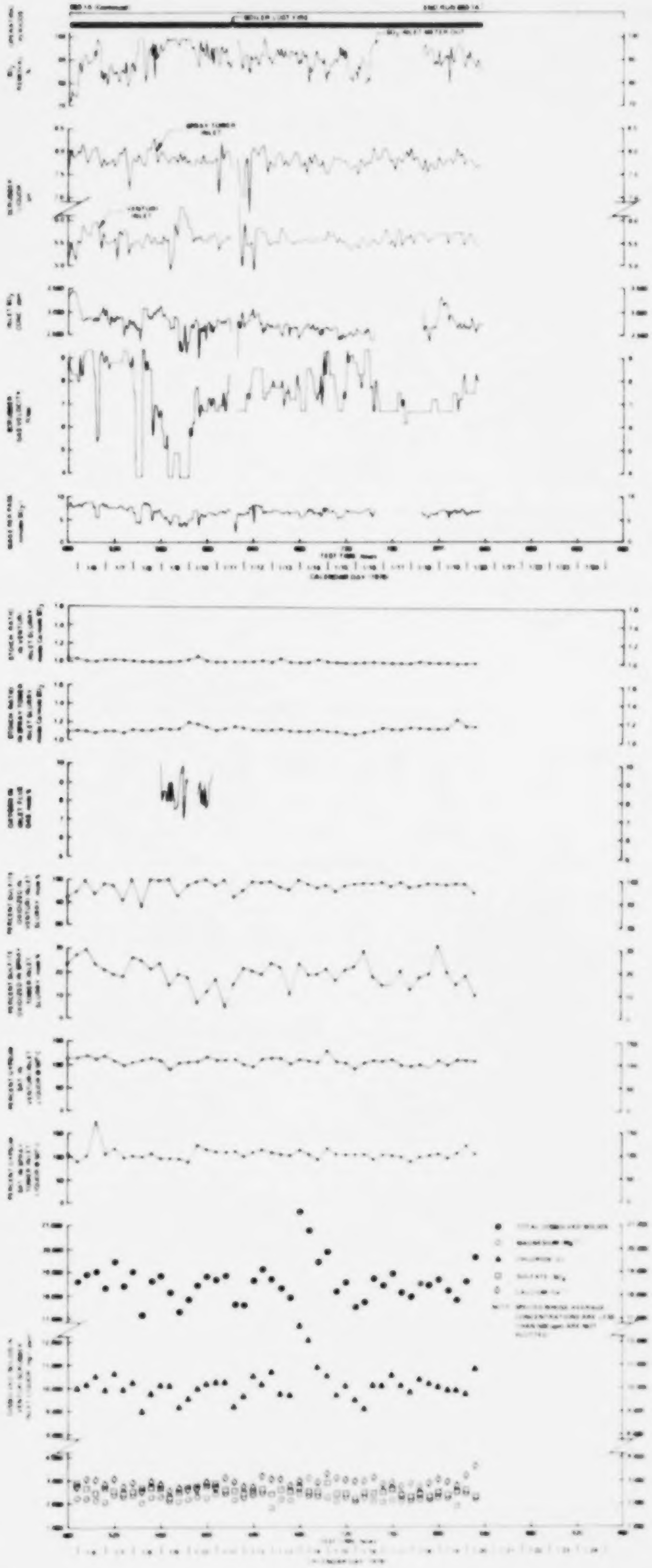
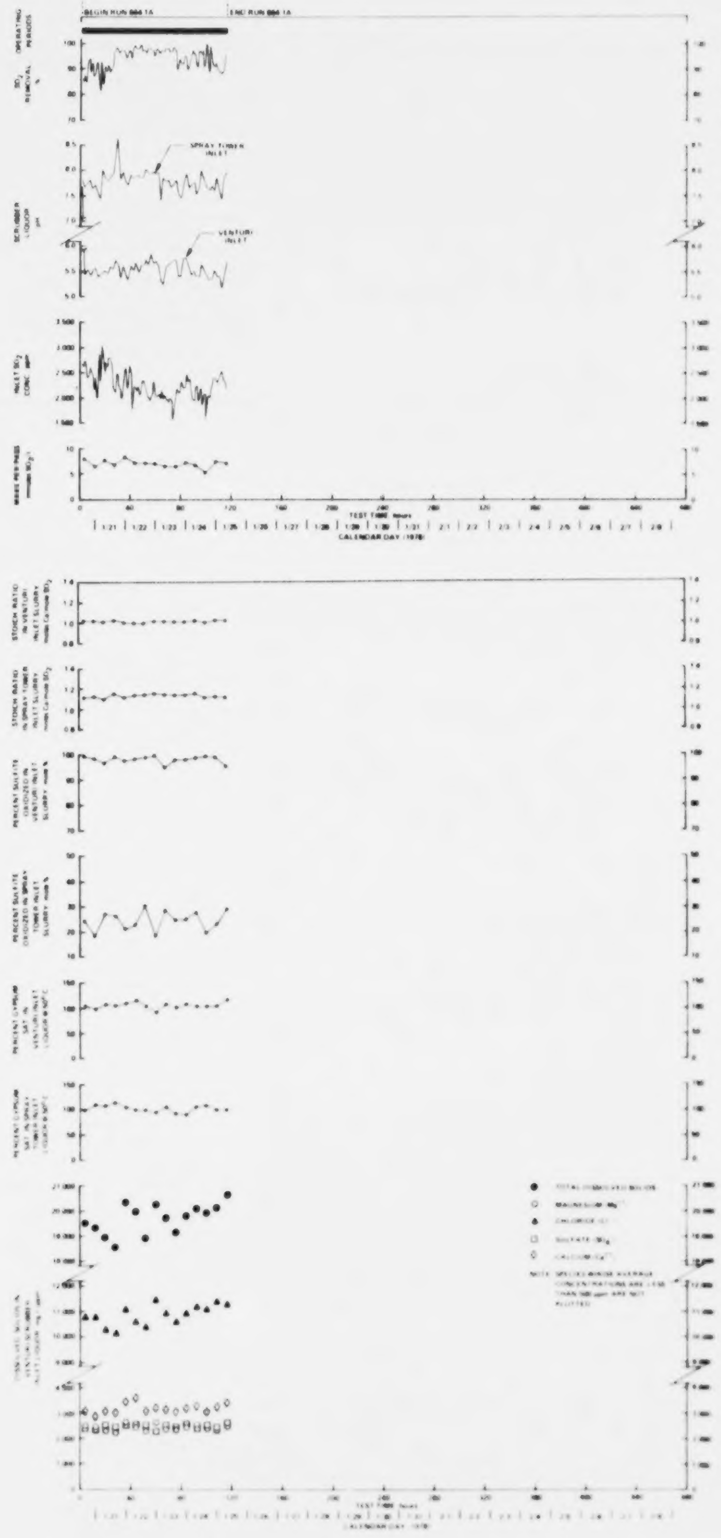


Figure F-39. OPERATING DATA FOR VENTURI/SPRAY TOWER RUN 863-1A



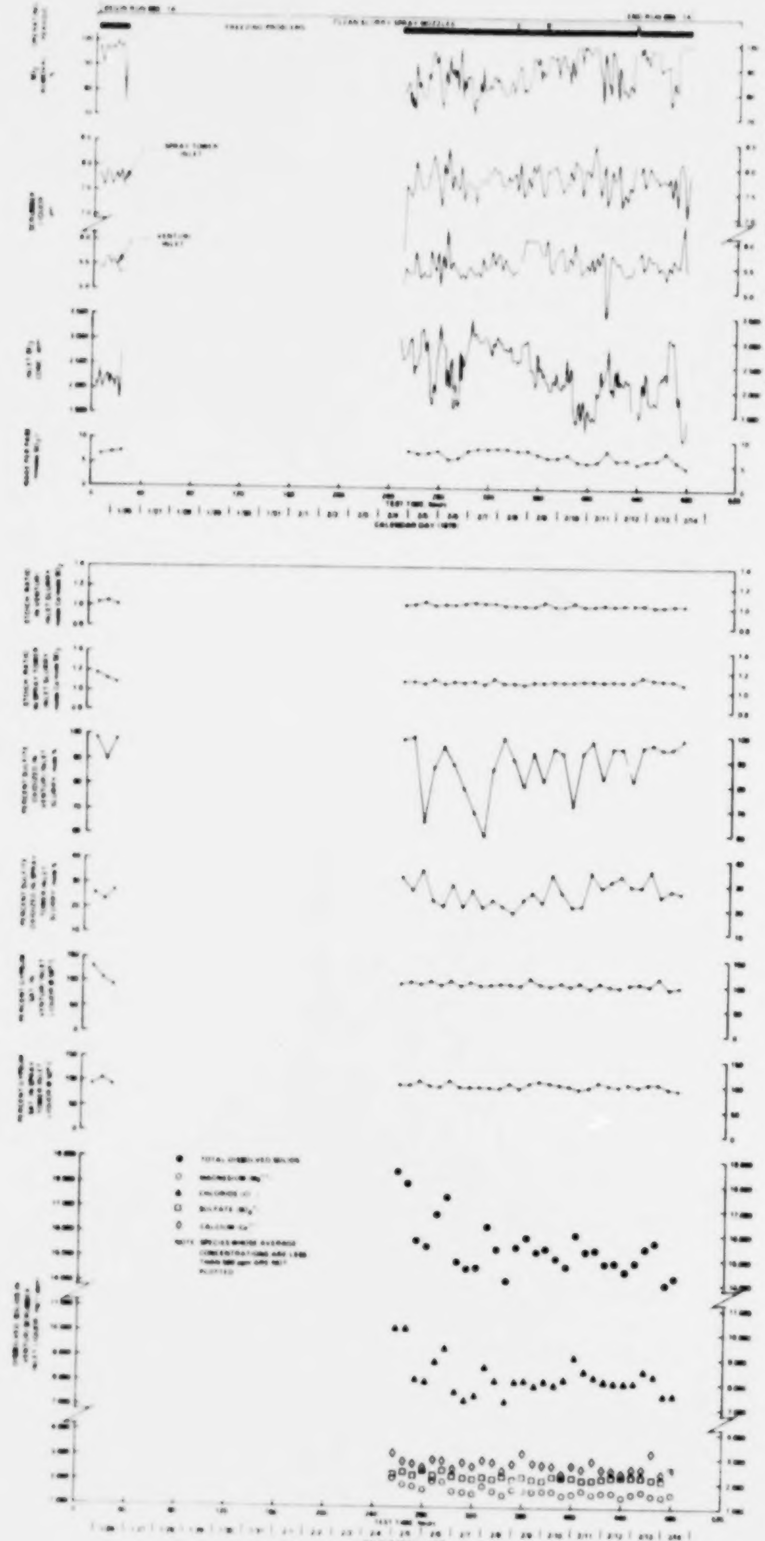
Gas Rate = 18,000-35,000 acfm @ 300° F
Spray Tower Gas Velocity = 4.8-9.4 ft/sec
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1600 gpm
Venturi L/G = 21-42 gal/Mcf
Spray Tower L/G = 57-111 gal/Mcf
No. of Spray Headers = 4
Residence Times
  Spray Tower Hold Tank = 14.7 min
  Oxidation Tank = 11.3 min
  Desupersaturation Tank = 4.7 min
Solids Recirculated, Venturi Loop = 13.3-17.7 wt %
Solids Recirculated, Spray Tower Loop = 8.9-11.9 wt %
Venturi Pressure Drop = 2.2-8.9 in. H_2O
Total Pressure Drop, Excl. Mist Elim.
  = 4.9-16.2 in. H_2O
Mist Elim. Pressure Drop = 0.06-0.61 in. H_2O
Air Flow Rate to Oxidizer = 210 scfm
Discharge (Clarifier & Filter) Solids
  Concentration = 80-88 wt %
Lime Addition to Venturi Downcomer and
  Spray Tower EHT
Clarified Liquor Returned to Spray Tower EHT
  and Oxidation Tank

Figure F-39 (continued). OPERATING DATA FOR VENTURI/SPRAY TOWER RUN 863-1A



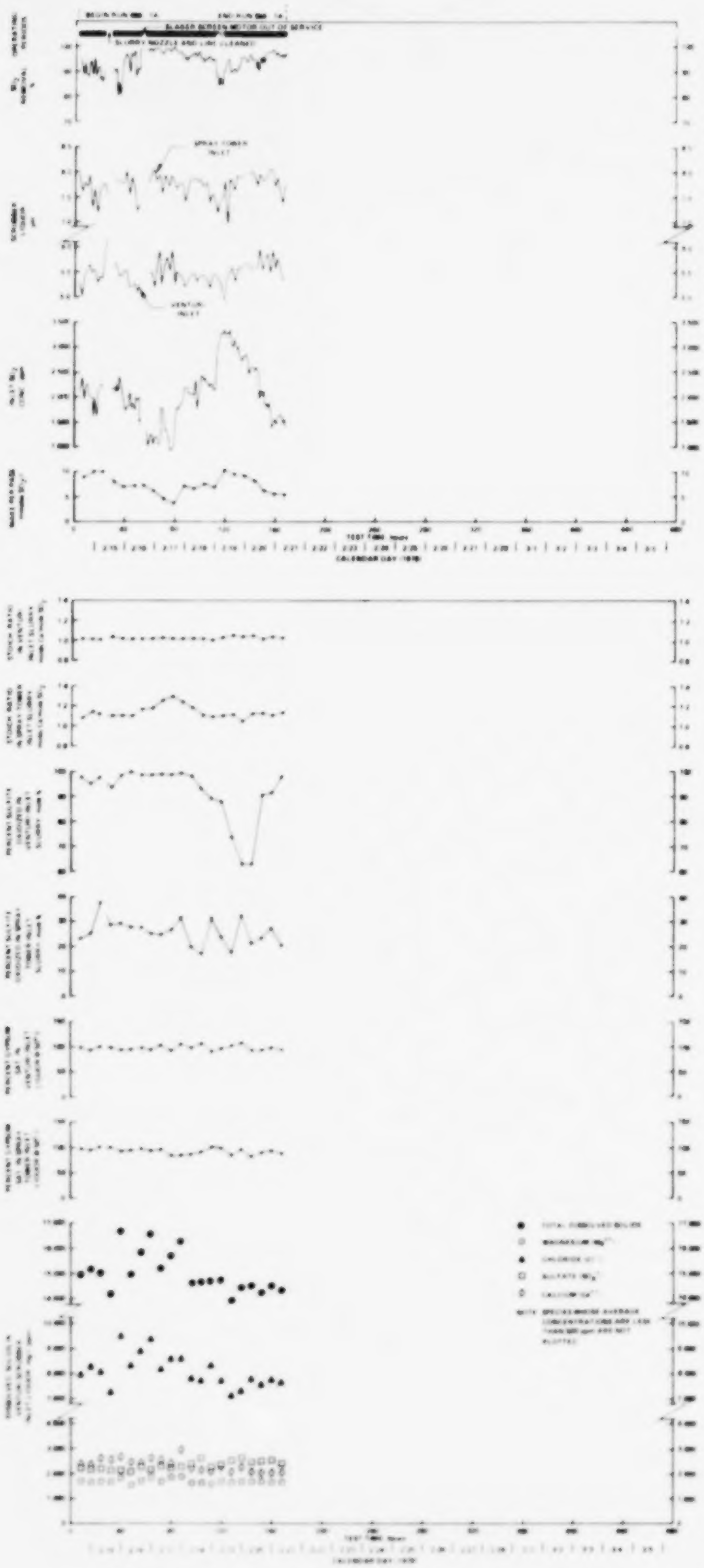
Gas Rate = 35,000 acfm @ 300° F
Spray Tower Gas Velocity = 9.4 ft/sec
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1600 gpm
Venturi L/G = 21 gal/Mcf
Spray Tower L/G = 57 gal/Mcf
No. of Spray Headers = 4
Residence Times
  Spray Tower Hold Tank = 14.7 min
  Oxidation Tank = 11.3 min
  Desupersaturation Tank = 4.7 min
Solids Recirculated, Venturi Loop = 15.2-16.6 wt %
Solids Recirculated, Spray Tower Loop = 9.1-9.9 wt %
Venturi Pressure Drop = 9.0 in. H_2O
Total Pressure Drop, Excl. Mist Elim.
  = 13.9-16.7 in. H_2O
Mist Elim. Pressure Drop = 0.48-0.68 in. H_2O
Air Flow Rate to Oxidizer = 210 scfm
Discharge (Clarifier & Filter) Solids
  Concentration = 81-88 wt %
Lime Addition to Venturi Downcomer and
  Spray Tower EHT
Clarified Liquor Returned to Spray Tower EHT
  and Oxidation Tank

Figure F-40. OPERATING DATA FOR VENTURI/SPRAY TOWER RUN 864-1A



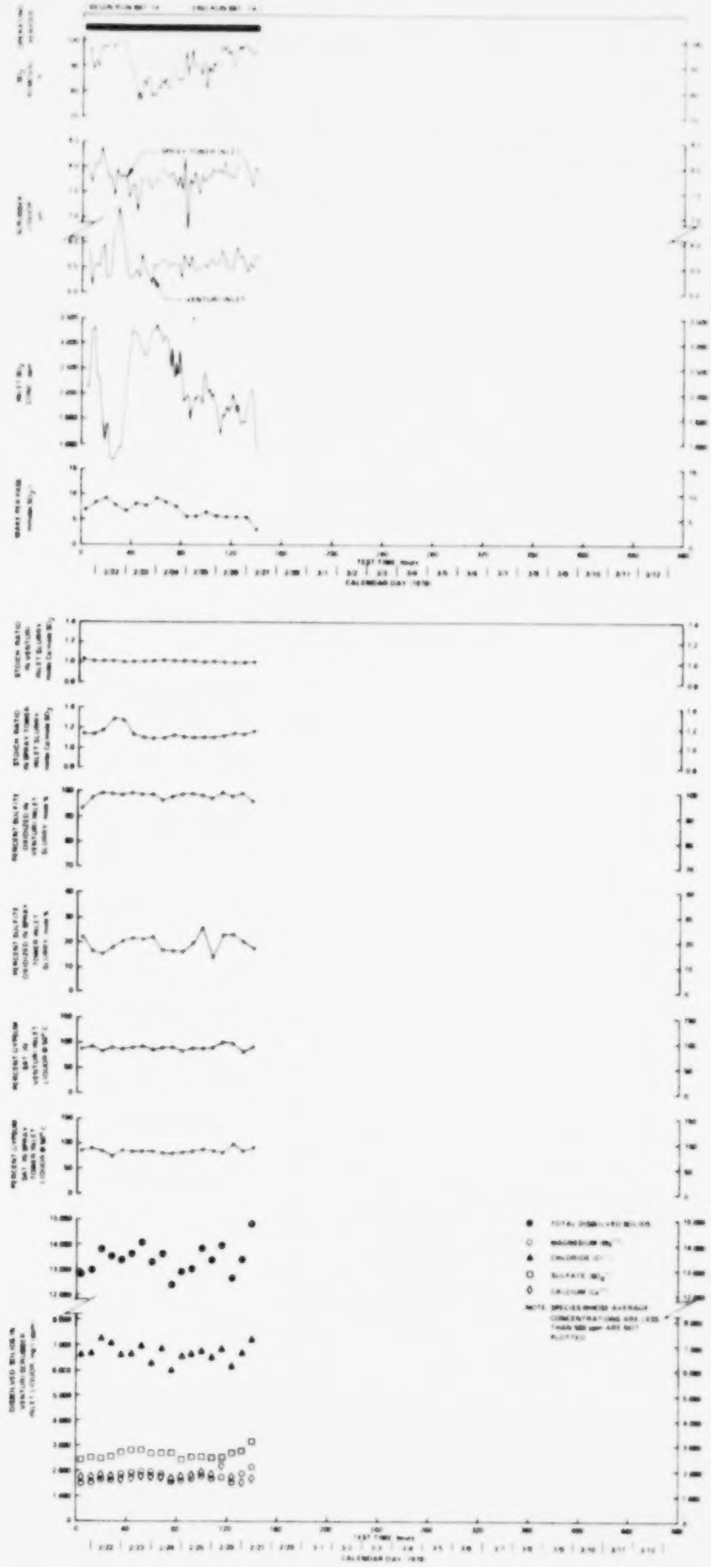
Gas Rate = 35,000 acfm @ 300° F
Spray Tower Gas Velocity = 9.4 ft/sec @ 125° F
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1600 gpm
Venturi L/G = 21 gal/Mcf
Spray Tower L/G = 57 gal/Mcf
No. of Spray Headers = 4
Residence Times
    Spray Tower EHT = 14.7 min
    Oxidation Tank = 6.3 min
    Desuperaturation Tank = 4.7 min
Solids Recirculated, Venturi Loop = 14.0 - 16.8 wt %
Solids Recirculated, Spray Tower Loop = 9.0 - 11.2 wt %
Venturi Pressure Drop = 9.0 in. H_2O
Total Pressure Drop, Excl. Mist Elim.
    = 13.8 - 16.2 in. H_2O
Mist Elim. Pressure Drop = 0.56 - 0.78 in. H_2O
Air Flow Rate to Oxidizer = 200/210 scfm
Discharge (Clarifier & Filter) Solids
    Concentration = 76 - 84 wt %
Lime Addition to Venturi Downcomer and Spray Tower EHT
Clarified Liquor Returned to Spray Tower EHT and Oxidation Tank

Figure F-41. OPERATING DATA FOR VENTURI/SPRAY TOWER RUN 865-1A



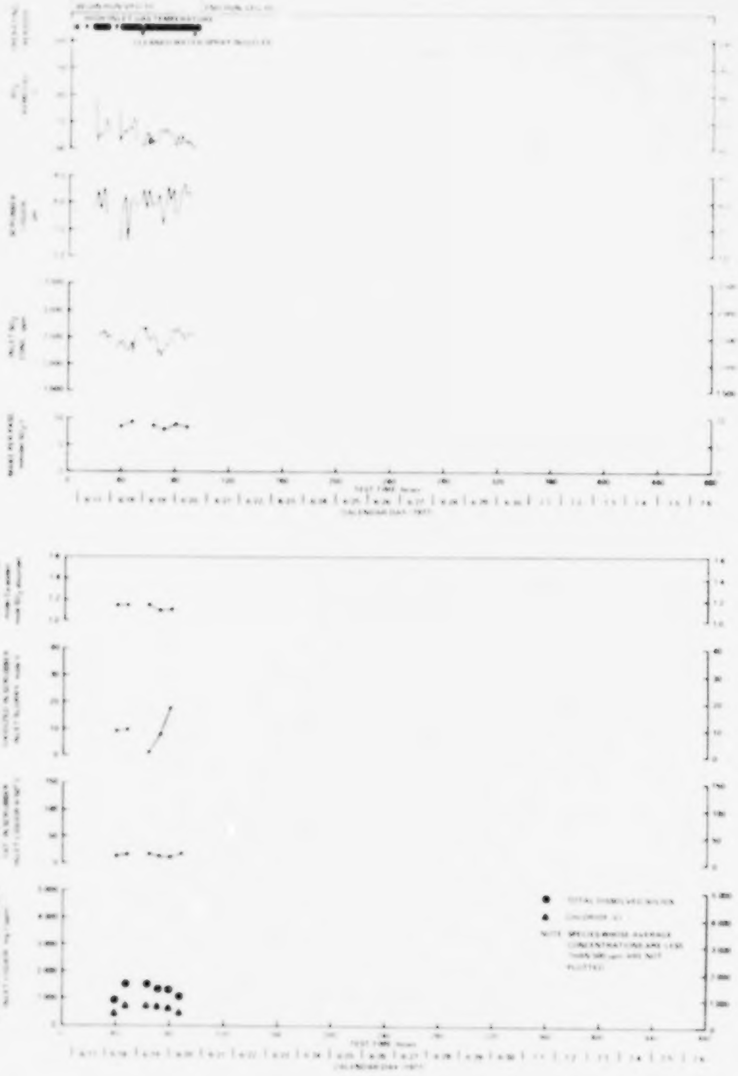
Gas Rate = 35,000 acfm @ 300° F
Spray Tower Gas Velocity = 9.4 ft/sec @ 125° F
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1600 gpm
Venturi L/G = 21 gal/Mcf
Spray Tower L/G = 57 gal/Mcf
No. of Spray Headers = 4
Residence Times
    Spray Tower EHT = 14.7 min
    Oxidation Tank = 6.3 min
    Desupersaturation Tank = 4.7 min
Solids Recirculated, Venturi Loop = 14.3 - 16.7 wt %
Solids Recirculated, Spray Tower Loop = 8.7 - 11.1 wt %
Venturi Pressure Drop = 9.0 in. H_2O
Total Pressure Drop, Excl. Mist Elim.
    = 15.3 - 17.6 in. H_2O
Mist Elim. Pressure Drop = 0.61 - 0.75 in. H_2O
Air Flow Rate to Oxidizer = 350 scfm
Discharge (Clarifier & Filter) Solids
    Concentration = 78 - 84 wt %
Lime Addition to Venturi Downcomer and Spray Tower EHT
Clarified Liquor Returned to Spray Tower EHT and Oxidation Tank

Figure F-42. OPERATING DATA FOR VENTURI/SPRAY TOWER RUN 866-1A



Gas Rate = 35,000 acfm @ 300° F
Spray Tower Gas Velocity = 3.4 ft/sec @ 125° F
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1800 gpm
Venturi L/G = 21 gal/Mcf
Spray Tower L/G = 57 gal/Mcf
No. of Spray Headers = 4
Residence Times
  Spray Tower EHT = 14.7 min
  Oxidation Tank = 8.8 min
  Desupersaturation Tank = 4.7 min
Solids Recirculated, Venturi Loop = 13.3 - 15.6 wt %
Solids Recirculated, Spray Tower Loop = 9.8 - 13.8 wt %
Venturi Pressure Drop = 9.0 in. H_2O
Total Pressure Drop, Excl. Mist Elim.
  = 15.4 - 17.2 in. H_2O
Mist Elim. Pressure Drop = 0.66 - 0.82 in. H_2O
Air Flow Rate to Oxidizer = 210 acfm
Discharge (Clarifier & Filter) Solids
  Concentration = 83 - 88 wt %
Lime Addition to Venturi Downcomer and Spray Tower EHT
Clarified Liquor Returned to Spray Tower EHT and Oxidation Tank

Figure F-43. OPERATING DATA FOR VENTURI/SPRAY TOWER RUN 867-1A



Gas Rate : 35,000 acfm @ 300° F
Spray Tower Gas Velocity : 9.4 ft/sec
Liquor Rate to Venturi : 0 gpm
Liquor Rate to Spray Tower : 1400 gpm
Venturi L/G : 0 gal/Mcf
Spray Tower L/G : 50 gal/Mcf
No. of Spray Headers : 4
EHT Residence Time : 18 min

Percent Solids Recirculated : 14.8-15.5 wt %
Venturi Pressure Drop : 2.2-2.8 in. H_2O (Plug 100% Open)
Total Pressure Drop, Excluding Mist Elim.
: 6.6-7.2 in. H_2O
Mist Elim. Pressure Drop : 0.62-0.68 in. H_2O
Lime Addition to EHT

Figure F-44. OPERATING DATA FOR VENTURI/SPRAY TOWER RUN VFG-1Q

Appendix G

AVERAGE LIQUOR COMPOSITIONS FOR THE VENTURI/SPRAY TOWER TESTS

The values in these tables are averages for steady-state operating periods.

Percent sulfite oxidized is measured in the bleed stream from the scrubber system.

Calculated Percent Gypsum Saturation = (activity Ca^{++}) x (activity $SO_4^{=}$)/ (solubility product at 50°C). Estimated solubility product for $CaSO_2 \cdot 2H_2O$ at 50°C is 2.2×10^{-5} (ref. Radian Corporation, "A Theoretical Description of the Limestone-Injection Wet Scrubbing Process, NAPCA Report June 9, 1970).

Run No.	Percent Solids Discharged	Percent Sulfite Oxidized	Sample Point	pH	Liquor Species Concentration, mg/l (ppm)								Calculated Percent Gypsum Saturation @ 50°C	Percent Error In Ionic Imbalance
					Ca^{++}	Mg^{++}	Na^{+}	K^{+}	$SO_3^{=}$	$SO_4^{=}$	Cl^{-}	Total		
801-1A	81	93	Spray Tower Inlet	5.75	885	370	26	31	230	1640	1220	4380	75	6.3
			Spray Tower Outlet	--	1080	400	29	34	390	2020	1330	5280	100	3.4
			Venturi Inlet	4.60	1250	615	43	54	29	2150	2360	6510	100	4.1
			Venturi Outlet	3.95	1480	675	61	64	410	2535	2770	8000	120	-1.4
802-1A	86	95	Spray Tower Inlet	5.55	1325	495	61	46	215	2230	2060	6430	110	2.6
			Spray Tower Outlet	--	1415	545	52	38	300	2300	2290	6940	115	1.4
			Venturi Inlet	4.95	1635	730	76	75	24	2170	3550	8260	110	1.0
			Venturi Outlet	4.30	1880	715	73	73	475	2545	3580	9340	135	-1.2
803-1A	81	96	Spray Tower Inlet	5.70	1660	550	62	60	150	2180	2880	7540	120	2.5
			Spray Tower Outlet	--	1670	540	58	58	190	2210	2810	7540	125	2.6
			Venturi Inlet	5.00	2120	790	115	105	21	1900	4730	9780	105	3.1
			Venturi Outlet	4.35	2300	800	115	105	310	2330	4840	10800	130	-0.1
804-1A	85	97	Spray Tower Inlet	5.80	1660	580	64	69	130	1970	3200	7670	105	1.3
			Spray Tower Outlet	--	1670	575	69	68	175	2000	3150	7710	110	1.5
			Venturi Inlet	5.05	2280	875	130	120	22	1930	5360	10720	105	1.7
			Venturi Outlet	4.45	2450	900	120	125	385	2300	5530	11810	130	-1.8
805-1A	81	98	Spray Tower Inlet	6.15	550	435	64	97	92	735	1545	3520	25	11.6
			Spray Tower Outlet	--	575	420	74	109	102	710	1585	3575	25	11.5
			Venturi Inlet	4.95	2230	1135	135	180	16	1980	6120	11800	95	0.7
			Venturi Outlet	4.35	2350	1130	135	185	325	2400	6200	12730	120	-3.5
806-1A	84	99	Spray Tower Inlet	6.15	390	390	40	38	93	735	1125	2810	20	10.3
			Spray Tower Outlet	--	380	390	41	38	99	700	1090	2740	20	12.6
			Venturi Inlet	4.60	2060	1225	165	170	16	2060	5970	11670	95	1.9
			Venturi Outlet	3.65	2205	1230	165	175	350	2330	6110	12560	105	-0.7
806-1B	82	98	Spray Tower Inlet	6.10	615	385	35	31	101	1425	1115	3710	55	2.8
			Spray Tower Outlet	--	630	380	35	31	86	1545	1090	3800	60	1.0
			Venturi Inlet	4.55	2200	1250	190	16	15	2040	6480	12340	95	-1.6
			Venturi Outlet	3.75	2215	1265	190	170	250	2430	6580	13200	115	-2.7
806-1C	79	97	Spray Tower Inlet	6.00	560	315	40	30	101	1275	970	3290	50	1.4
			Spray Tower Outlet	--	565	310	37	30	180	1190	900	3210	45	5.0
			Venturi Inlet	4.55	[illegible]	1170	185	175	15	2250	5540	11240	100	0.5
			Venturi Outlet	3.65	2045	1190	190	180	275	2605	5570	12060	115	-0.5
806-1D	79	67	Spray Tower Inlet	6.15	310	400	41	33	115	685	995	2580	15	13.1
			Spray Tower Outlet	--	305	375	41	33	107	665	975	2500	15	11.3
			Venturi Inlet	4.55	2030	1190	205	185	130	2280	5275	11300	105	7.2
			Venturi Outlet	4.25	2250	1205	205	180	700	2600	5470	12610	125	3.6

Run No.	Percent Solids Discharged	Percent Sulfite Oxidized	Sample Point	pH	Liquor Species Concentration, mg/l (ppm)								Calculated Percent Gypsum Saturation @ 50°C	Percent Error In Ionic Imbalance
					Ca^{++}	Mg^{++}	Na^{+}	K^{+}	$SO_3^{=}$	$SO_4^{=}$	Cl^{-}	Total		
807-1A	74	18	Spray Tower Inlet	6.30	155	335	37	34	155	560	695	1970	10	9.9
			Spray Tower Outlet	--	--	--	--	--	--	--	--	--	--	--
			Venturi Inlet	4.50	1910	1020	215	155	555	2930	4315	11100	135	1.6
			Venturi Outlet	4.35	2030	1030	215	175	985	3065	4480	11990	145	-1.3
808-1A	82	97	Spray Tower Inlet	6.25	265	225	40	33	105	845	260	1770	25	21.9(a)
			Spray Tower Outlet	--	--	--	--	--	--	--	--	--	--	--
			Venturi Inlet	4.55	1565	1115	210	150	19	2470	4255	9790	100	6.3
			Venturi Outlet	3.55	1670	1105	200	155	325	2805	4370	10630	115	1.1
809-1A	80/35	98	Spray Tower Inlet	5.7	1815	710	70	45	100	2000	3560	8300	105	6.1
			Spray Tower Outlet	--	1915	735	75	45	170	2015	3740	8695	110	6.6
			Venturi Inlet	4.5	2830	1295	110	65	35	1835	7150	13320	95	5.5
			Venturi Outlet	3.4	2860	1285	110	70	150	2115	7000	13590	110	4.8
810-1A	46	98	Spray Tower Inlet	5.8	1445	640	65	30	90	2120	2655	7045	105	6.0
			Spray Tower Outlet	--	1475	645	70	30	110	2135	2680	7145	105	6.8
			Venturi Inlet	5.1	1870	1140	100	60	25	2170	4950	10315	95	4.1
			Venturi Outlet	4.2	2040	1145	105	60	280	2425	4980	11035	110	3.8
811-1A	45	97	Spray Tower Inlet	5.9	1260	595	70	30	110	2280	2150	6495	105	4.8
			Spray Tower Outlet	--	1260	590	70	30	125	2275	2135	6485	105	5.2
			Venturi Inlet	5.5	1490	1030	100	50	45	2550	3600	8865	105	5.7
			Venturi Outlet	4.6	1560	1045	10	55	475	2630	3650	9425	110	1.1
812-1A	86	98	Spray Tower Inlet	5.9	1215	775	70	35	110	2480	2530	7215	100	2
			Spray Tower Outlet	--	1235	785	70	35	140	2495	2565	7325	100	3
			Venturi Inlet	5.6	1530	1120	100	50	60	2690	4070	9620	105	1
			Venturi Outlet	4.8	1630	1140	105	50	360	2980	4125	10390	120	-1
814-1A	88	98	Spray Tower Inlet	6.0	1280	870	80	40	120	2530	2760	7680	100	5
			Spray Tower Outlet	--	1250	865	80	35	120	2595	2720	7665	100	4
			Venturi Inlet	5.6	1515	1405	130	65	25	3030	4385	10555	105	6
			Venturi Outlet	4.6	1260	1355	135	60	310	3230	4340	10690	100	-7

(a) The liquid ionic imbalance for the spray tower inlet liquor averaged +22% for this run. Analysis of some selected samples showed an average of about 210 ppm liquor $CO_3^{=}$. Since the total dissolved solids concentration was low, inclusion of $CO_3^{=}$ would have improved the ionic imbalance.

Run No.	Percent Solids Discharged	Percent Sulfite Oxidized	Sample Point	pH	Liquor Species Concentration, mg/l (ppm)								Calculated Percent Gypsum Saturation @ 50°C	Percent Error In Ionic Imbalance
					Ca^{++}	Mg^{++}	Na^{+}	K^{+}	$SO_3^{=}$	$SO_4^{=}$	Cl^{-}	Total		
815-1A	87	96	Spray Tower Inlet	5.8	1565	1095	95	45	125	2540	3830	9295	105	6
			Spray Tower Outlet	5.6	1605	1090	100	45	140	2570	3820	9370	105	7
			Venturi Inlet	5.6	2015	1615	145	70	40	2665	6060	12610	105	6
			Venturi Outlet	4.6	2165	1560	140	70	455	2925	6010	13325	120	3
816-1A	86	98	Spray Tower Inlet	5.7	1780	1175	115	50	125	2535	4640	10420	105	3
			Spray Tower Outlet	5.6	1790	1200	105	45	140	2490	4630	10400	105	5
			Venturi Inlet	5.5	2360	1955	195	80	25	2595	7650	14860	100	7
			Venturi Outlet	4.5	2460	1935	185	85	350	2890	7665	15570	115	4
817-1A	86	97	Spray Tower Inlet	5.9	1990	830	85	50	85	1875	4360	9275	100	5
			Spray Tower Outlet	5.8	1985	795	90	55	90	1890	4410	9315	100	3
			Venturi Inlet	5.5	3355	1535	195	135	25	1945	8730	15920	105	6
			Venturi Outlet	4.7	3560	1575	180	120	300	2425	8810	16970	130	5
818-1A	86	98	Spray Tower Inlet	5.9	2055	905	105	85	105	1940	4790	9985	100	3
			Spray Tower Outlet	5.8	2085	920	105	100	125	1955	4885	10175	100	3
			Venturi Inlet	5.6	3610	1790	210	175	25	2030	9450	17290	105	9
			Venturi Outlet	4.6	3830	1790	170	185	330	2455	9580	18340	130	7
819-1A	87	98	Spray Tower Inlet	5.85	2200	1240	150	150	110	2125	6130	12105	100	1
			Spray Tower Outlet	5.7	2220	1245	150	150	125	2155	6135	12180	100	2
			Venturi Inlet	5.45	3520	2275	275	280	25	2180	10890	19445	100	8
			Venturi Outlet	4.5	3710	2310	280	285	350	2505	10970	20410	115	7
819-1B	86	98	Spray Tower Inlet	5.9	2350	1360	155	140	120	2345	6020	12490	110	8
			Spray Tower Outlet	5.7	2330	1330	150	145	125	2405	5935	12420	110	7
			Venturi Inlet	5.5	3455	2455	270	245	25	2460	10440	19350	105	12
			Venturi Outlet	4.45	3695	2460	300	255	325	2850	10490	20375	130	12
820-1A	85	98	Spray Tower Inlet	6.05	580	5630	50	30	1375	20360	1400	29425	100	1.0
			Spray Tower Outlet	--	--	--	--	--	--	--	--	--	--	--
			Venturi Inlet	5.55	615	9350	185	145	50	35015	2735	48095	130	0.6
			Venturi Outlet	4.85	675	9260	195	150	420	35100	2740	48540	140	-0.7
820-1B	82	92	Spray Tower Inlet	5.90	640	5595	65	50	1400	18700	1780	28230	105	6.2
			Spray Tower Outlet	--	--	--	--	--	--	--	--	--	--	--
			Venturi Inlet	5.20	705	9435	195	140	950	31630	4095	47150	130	4.3
			Venturi Outlet	4.95	755	9350	205	130	1565	31285	4180	47470	140	3.4
820-1C	63	36	Spray Tower Inlet	5.90	615	5510	70	75	1545	16930	2360	27105	90	8.5
			Spray Tower Outlet	5.70	625	5450	70	75	1710	16865	2350	27145	95	7.8
			Venturi Inlet	4.80	925	9330	170	135	5585	26355	4420	46920	145	9.1
			Venturi Outlet	4.60	965	9260	165	150	6280	26215	4575	47610	150	14.4

Run No.	Percent Solids Discharged	Percent Sulfite Oxidized	Sample Point	pH	Liquor Species Concentration, mg/l (ppm)								Calculated Percent Gypsum Saturation @ 50^{o}C	Percent Error In Ionic Imbalance
					Ca^{++}	Mg^{++}	Na^{+}	K^{+}	$SO_3^{=}$	$SO_4^{=}$	Cl^{-}	Total		
822-1A	85	97	Spray Tower Inlet	5.75	665	6100	95	75	1685	18700	3515	30835	100	4.2
			Spray Tower Outlet	5.60	710	6180	95	80	2055	18405	3510	31035	105	6.0
			Venturi Inlet	5.20	715	10465	195	150	735	31350	6870	50480	125	5.6
			Venturi Outlet	4.85	745	10465	190	155	1150	31340	6940	50985	130	5.1
822-1B	85	98	Spray Tower Inlet	5.55	780	5985	95	75	3280	17350	3325	30890	110	5.2
			Spray Tower Outlet	5.40	860	5870	95	75	3480	17025	3245	30650	120	6.0
			Venturi Inlet	5.05	740	9190	185	155	410	28340	5750	44770	130	5.8
			Venturi Outlet	4.65	755	9245	190	160	995	28295	5825	45465	130	5.4
823-1A	83	98	Scrubber Inlet	5.25	880	5870	95	95	5445	16630	2565	31580	120	6.2
			Spray Tower Outlet	5.05	895	5830	90	95	5505	16655	2545	31615	125	6.4
			Venturi Outlet	4.85	950	5900	95	95	5935	16835	2595	32405	135	6.4
			Oxidation Tank	6.30	655	5820	95	95	65	19900	2535	29165	115	6.0
824-1A	85	97	Scrubber Inlet	5.25	605	6125	105	110	5175	17495	2655	32270	85	4.7
			Spray Tower Outlet	5.15	645	6115	105	105	5605	17125	2680	32380	90	5.3
			Venturi Outlet	4.75	690	6270	105	110	6035	17075	2750	33035	95	7.8
			Oxidation Tank	5.90	505	6160	105	110	105	21000	2700	30685	90	4.5
825-1A	85	97	Scrubber Inlet	5.45	655	6570	105	115	2615	21050	3475	34585	105	0.3
			Spray Tower Outlet	5.35	690	6405	110	115	2740	20900	3470	34430	110	-0.9
			Venturi Outlet	5.05	755	6615	105	120	3020	21250	3510	35375	125	0.8
			Oxidation Tank	5.65	625	6645	100	120	220	23185	3570	34465	115	-0.3
826-1A	84	96	Scrubber Inlet	5.35	685	6300	120	125	2890	18995	3880	32995	105	2.8
			Spray Tower Outlet	5.30	725	6350	115	125	3030	18955	3820	33120	110	3.3
			Venturi Outlet	5.00	795	6410	120	125	3405	19035	3925	33830	120	3.6
			Oxidation Tank	5.45	665	6515	120	125	230	21265	3955	32875	115	3.4
851-1A	81	97	Spray Tower Inlet	7.90	1150	705	59	60	76	1935	2385	6370	80	8.5
			Spray Tower Outlet	--	1145	740	59	66	222	1980	2355	6570	80	7.6
			Venturi Inlet	4.45	1445	1140	125	105	39	2505	3705	9070	95	9.9
			Venturi Outlet	--	1540	1165	120	110	195	2920	3805	9860	110	5.8
852-1A	73	83	Spray Tower Inlet	7.80	850	700	60	74	56	1345	2235	5330	50	11.7
			Spray Tower Outlet	--	850	745	61	76	277	1435	2265	5710	50	7.2
			Venturi Inlet	5.65	1575	1205	140	135	22	2720	3960	9760	105	10.1
			Venturi Outlet	--	1970	1305	140	150	980	3100	4485	12140	130	3.8
853-1A	78	97	Spray Tower Inlet	8.05	1235	845	61	81	68	1970	2675	6940	80	13.2
			Spray Tower Outlet	5.50	1210	905	61	79	235	2160	2615	7270	85	12.4
			Venturi Inlet	4.80	1565	1350	150	135	35	2680	4195	10110	100	12.5
			Venturi Outlet	--	1730	1350	145	130	310	3000	4205	10870	115	10.7

Run No.	Percent Solids Discharged	Percent Sulfite Oxidized	Sample Point	pH	Liquor Species Concentration, mg/l (ppm)								Calculated Percent Gypsum Saturation @ 50^oC	Percent Error In Ionic Imbalance
					Ca^{++}	Mg^{++}	Na^+	K^+	$SO_3^=$	$SO_4^=$	Cl^-	Total		
854-1A	79	96	Spray Tower Inlet	8.00	1070	885	64	82	63	1530	2855	6560	55	13.2
			Spray Tower Outlet	5.65	1040	920	62	82	235	1610	2835	6790	55	11.5
			Venturi Inlet	5.05	1650	1295	150	130	35	2590	4285	10140	100	12.0
			Venturi Outlet	3.80	1820	1335	155	135	385	3075	4455	11360	125	8.1
855-1A	75	98	Spray Tower Inlet	8.10	845	75	17	18	35	1505	460	2955	95	8.8
			Spray Tower Outlet	--	915	175	18	20	215	1730	570	3645	100	9.9
			Venturi Inlet	4.70	1045	305	33	35	24	1985	990	4415	105	12.6
			Venturi Outlet	3.05	1200	290	37	37	315	2090	1090	5060	120	10.3
856-1A	83	97	Spray Tower Inlet	8.05	945	215	19	23	57	1625	860	3745	90	10.2
			Spray Tower Outlet	--	965	270	21	23	235	1765	840	4120	95	10.1
			Venturi Inlet	5.00	1280	565	43	43	36	1950	2060	5975	95	11.7
			Venturi Outlet	3.65	1460	570	44	43	475	2105	2140	6835	110	10.7
857-1A	78	97	Spray Tower Inlet	8.05	1210	445	29	32	88	1760	1840	5405	90	8.4
			Spray Tower Outlet	--	1230	470	30	34	330	1825	1805	5725	95	8.1
			Venturi Inlet	5.40	1780	840	55	49	64	1990	3630	8410	100	10.4
			Venturi Outlet	4.25	1955	860	55	48	505	2115	3700	9240	110	10.0
858-1A	81	97	Spray Tower Inlet	8.00	985	300	29	30	47	1595	1245	4230	85	8.4
			Spray Tower Outlet	5.40	990	335	31	31	210	1710	1260	4570	85	6.1
			Venturi Inlet	5.50	2445	1060	62	59	20	2060	5145	10850	110	11.7
			Venturi Outlet	3.65	2610	1065	61	63	425	2145	5270	11640	120	10.8
859-1A	74	76	Spray Tower Inlet	8.1	1350	570	35	30	78	1220	2785	6070	60	9.1
			Spray Tower Outlet	--	1340	590	35	32	195	1380	2745	6320	70	7.3
			Venturi Inlet	5.50	2115	960	69	59	99	1855	4535	9690	95	11.0
			Venturi Outlet	4.60	2330	935	72	60	840	2125	4520	10880	115	7.6
859-1B	78	99	Spray Tower Inlet	7.95	1440	595	57	39	63	1775	2565	6535	90	10.8
			Spray Tower Outlet	--	1465	610	52	40	295	1890	2515	6865	95	9.2
			Venturi Inlet	5.55	2010	1045	92	68	33	2140	4390	9780	105	12.0
			Venturi Outlet	4.2	2170	1190	91	68	515	2330	3995	10360	115	20.9
859-1C	71	69	Spray Tower Inlet	8.0	1445	595	47	33	48	1710	2755	6635	90	7.6
			Spray Tower Outlet	--	1415	595	49	35	260	1740	2645	6740	90	6.3
			Venturi Inlet	5.5	2330	950	90	51	82	1900	4950	10355	105	9.6
			Venturi Outlet	4.55	2580	990	100	54	930	1970	5095	11720	110	8.8
859-1D	55	30	Spray Tower Inlet	8.00	1265	595	51	31	53	1015	2975	5985	50	7.5
			Spray Tower Outlet	--	1250	585	51	32	67	945	2930	5860	45	9.1
			Venturi Inlet	5.45	2295	1005	92	55	85	2155	4890	10575	115	9.1
			Venturi Outlet	4.60	2350	1005	92	53	755	2250	4925	11430	120	4.7

Run No.	Percent Solids Discharged	Percent Sulfite Oxidized	Sample Point	pH	Liquor Species Concentration, mg/l (ppm)								Calculated Percent Gypsum Saturation @ 50^{0}C	Percent Error In Ionic Imbalance
					Ca^{++}	Mg^{++}	Na^{+}	K^{+}	$SO_3^{=}$	$SO_4^{=}$	Cl^{-}	Total		
860-1A	82	99	Spray Tower Inlet	8.1	1490	595	55	35	40	1320	3060	6595	70	9.3
			Spray Tower Outlet	--	1510	620	55	35	50	1375	3065	6710	70	10.7
			Venturi Inlet	5.5	2800	1145	100	65	20	1850	6515	12495	100	7.2
			Venturi Outlet	3.8	2810	1135	105	55	265	2100	6420	12890	115	4.9
861-1A	86	98	Spray Tower Inlet	7.9	1810	1030	90	40	100	1970	4510	9550	90	5.0
			Spray Tower Outlet	5.8	1790	1065	90	45	120	2130	4565	9805	95	4.0
			Venturi Inlet	5.5	2625	1830	165	75	35	2225	8280	15235	95	4.0
			Venturi Outlet	3.3	2775	1845	155	80	320	2605	8065	15845	115	5.0
862-1A	86	97	Spray Tower Inlet	8.0	1485	685	70	40	85	1780	3180	7325	85	4.0
			Spray Tower Outlet	5.8	1475	700	70	40	180	1885	3140	7490	90	3.0
			Venturi Inlet	5.5	3200	1885	190	120	30	2245	9015	16685	105	8.0
			Venturi Outlet	4.3	3425	1890	195	120	455	2630	9095	17810	130	6.0
863-1A	85	97	Spray Tower Inlet	7.8	1955	1310	165	145	80	2380	5365	11400	100	6.0
			Spray Tower Outlet	5.1	2000	1315	165	145	350	2605	5310	11890	110	5.0
			Venturi Inlet	5.6	3000	2340	315	265	35	2580	10000	18535	105	7.0
			Venturi Outlet	4.35	3200	2345	310	280	465	2900	10055	19555	120	6.0
864-1A	85	98	Spray Tower Inlet	7.8	2200	1425	165	150	80	2335	5970	12325	100	8.0
			Spray Tower Outlet	--	2130	1405	165	130	200	2440	5905	12375	105	5.0
			Venturi Inlet	5.55	3205	2445	325	280	25	2500	10930	19710	100	6.0
			Venturi Outlet	4.2	3340	2440	330	285	345	2800	11060	20600	115	4.0
865-1A	80	89	Spray Tower Inlet	7.8	1805	990	145	125	90	2115	4465	9735	95	5.0
			Spray Tower Outlet	--	1840	1000	140	125	355	2320	4475	10255	105	1.6
			Venturi Inlet	5.6	2665	1610	270	245	65	2195	8015	15065	100	3.9
			Venturi Outlet	4.5	2870	1595	280	255	545	2510	8085	16140	120	2.1
866-1A	81	90	Spray Tower Inlet	7.8	1635	885	180	130	85	2005	4240	9160	90	1.4
			Spray Tower Outlet	--	1575	875	165	130	145	2040	4255	9185	90	-2.2
			Venturi Inlet	5.5	2345	1705	215	260	40	2360	8075	15000	95	-1.3
			Venturi Outlet	4.5	2470	1670	210	290	435	2720	8040	15835	115	-4.1
867-1A	86	98	Spray Tower Inlet	7.8	1235	905	120	115	75	2215	3375	8040	85	0.9
			Spray Tower Outlet	--	1240	915	130	115	230	2335	3365	8330	85	-1.0
			Venturi Inlet	5.55	1745	1790	215	245	40	2685	6700	13420	90	1.9
			Venturi Outlet	4.4	1860	1790	220	250	380	3100	6850	14450	105	-2.4
VFG-1Q	--	9	Spray Tower Inlet	8.02	415	14	19	22	21	180	620	1290	10	6.0

APPENDIX H

TEST RESULTS SUMMARY TABLES FOR THE TCA SYSTEM

Table H-1

SUMMARY OF LIMESTONE TESTING WITH MgO ADDITION ON THE TCA SYSTEM

Run Number	[illegible]	[illegible]	[illegible]	[illegible]
Start-of-Run Date	1/24/78	2/2/78	3/21/78	4/13/78
End-of-Run Date	[illegible]	2/6/78	4/5/78	4/21/78
On Stream Hours	45	97	[illegible]	201
Fly Ash Loading	High	High	High	High
MgO Addition	No	No	Yes	Yes
Gas Rate, acfm @ 300°F	[illegible]	[illegible]	[illegible]	[illegible]
Gas Velocity, fps @ 125°F	12.5	12.8	12.4	12.0
Liquor Rate, gpm	1200	1200	1200	1200
L/G, gal/Mcf	92	85	85	88
Percent Solids Recirculated	11.2 - 14.5	14.5 - 16.9	[illegible]	14.0 - 16.7
Effluent Residence Time, min.	4.1	4.1	4.1	4.1
Stoichiometric Ratio, moles Ca added/mole SO_2 absorbed	1.04 - 1.17	1.09 - 1.25	[illegible] (a)	[illegible] (b)
Avg. % Limestone Utilization, 100x moles SO_2 abs./mole Ca added	88	85	85 (a)	74 (b)
Inlet O_2 Concentration, vol. %	8.0 - 9.3			8.3 - 10.0
Inlet SO_2 Concentration, ppm	1900 - 2100	2000 - 2600	1600 - 3200	2200 - 2600
Percent SO_2 Removal	54 - 78	72 - 84	81 - 98	82 - 98
Avg. SO_2 Make Per Pass, mmole/l	7.1	5.5	13.7	13.4
Scrubber Inlet pH Range	4.8 - 5.2	5.35 - 5.6	5.30 - 5.60	[illegible]
Scrubber Outlet pH Range	4.75 - 4.95	4.85 - 5.30	5.05 - 5.55	[illegible]
Percent Sulfite Oxidized	30 - 43	29 - 37	22 - 30	33 - 40
Solids Disposal System	Clarifier & Centrifuge	Clarifier & Centrifuge	Clarifier & Centrifuge	Clarifier & Centrifuge
Solids in Sludge Discharged, %	62 - 70	56 - 68	58 - 70	61 - 69
Calculated Avg. % Gypsum Saturation in Scrubber Inlet Liquor @ 50°C	110	123	105	100
Total Dissolved Solids, ppm	5800 - 6800	5800 - 6200	29,500 - 32,100	43,500 - 51,900
Total ΔP Range Excluding Mist Elimination System, in. H_2O	10.2 - 12.5	9.5 - 11.6	8.6 - 11.3	7.4 - 10.0
Mist Elimination System ΔP Range, in. H_2O	0.40 - 0.48	0.42 - 0.52	0.44 - 0.61	0.55 - 0.68
Mist Elimination System Configuration	Three-pass, open-vane, 316L SS chevron mist eliminator.	Three-pass, open-vane, 316L SS chevron mist eliminator.	Three-pass, open-vane, 316L SS chevron mist eliminator.	Three-pass, open-vane 316L SS chevron mist eliminator.
Mist Eliminator Washing Scheme	Top washed sequentially with makeup water. Each nozzle (5 total) on for 1 min. (0.54 gpm/sq. ft.) with 7 min. off between nozzles. Bottom washed intermittently with makeup water. The nozzles (2 total) were on for 4 min. each hour (1.5 gpm/sq. ft.).	Top washed sequentially with makeup water. Each nozzle (5 total) on for 1 min. (0.54 gpm/sq. ft.) with 7 min. off between nozzles. Bottom washed intermittently with makeup water. The nozzles (2 total) were on for 4 min. each hour (1.5 gpm/sq. ft.).	Top washed sequentially with makeup water. Each nozzle (5 total) on for 1 min. (0.54 gpm/sq. ft.) with 7 min. off between nozzles. Bottom washed intermittently with makeup water. The nozzles (2 total) were on for 4 min. each hour (1.5 gpm/sq. ft.).	Top washed sequentially with makeup water. Each nozzle (5 total) on for 1 min. (0.54 gpm/sq. ft.) with 7 min. off between nozzles. Bottom washed intermittently with makeup water. The nozzles (2 total) were on for 4 min. each hour (1.5 gpm/sq. ft.).
Absorbent	Limestone slurried to 60 wt% with makeup water and added to the downcomer.	Limestone slurried to 60 wt% with makeup water and added to the downcomer.	Limestone slurried to 60 wt% with makeup water and added to EHT. MgO dry fed to EHT.	Limestone slurried to 60 wt% with makeup water and added to EHT. MgO dry fed to EHT.
Scrubber Internals	Three beds (4 grids) with nominally 5 inches/bed of nitrile foam spheres from Run 620-2A.	Three beds (4 grids) with nominally 5 inches/bed of nitrile foam spheres from Run 590-2A.	Three beds (4 grids) with nominally 5 inches/bed of nitrile foam spheres from Run [illegible]. Actual total bed height was 15 inches at beginning of the run.	Three beds (4 grids) with nominally 5 inches/bed of nitrile foam spheres from Run [illegible].
System Changes Before Start of Run	Bed height was reduced to 5 inches/bed from 7.5 inches/bed. Switched to external downcomer (D-204) from internal downcomer. No cleaning.	Switched to internal downcomer (D-204) from external downcomer. No cleaning.	Cleaned [illegible] line to effluent hold tank. Used nitrile foam spheres added to the middle bed to make up for losses.	No changes. No cleaning.
Method of Control	Limestone stoichiometric ratio controlled at 1.2. Hold tank (D-204) with external downcomer was used.	Limestone stoichiometric ratio controlled at 1.2. Hold tank (D-204) with internal downcomer was used.	Limestone stoichiometric ratio controlled at 1.2. Effective Mg^{++} ion concentration (total ppm Mg^{++} - ppm Cl⁻/2.92) controlled at 5000 ppm. Hold tank (D-204) with external downcomer was used.	Limestone stoichiometric ratio controlled at 1.2. Effective Mg^{++} ion concentration (total ppm Mg^{++} - ppm Cl⁻/2.92) controlled at 9000 ppm. Hold tank (D-204) with external downcomer was used.
Run Philosophy	A base case limestone run without MgO addition. The results will be compared with the succeeding limestone/MgO runs to observe the effect of Mg^{++} ion concentration on SO_2 removal and gypsum saturation. This run was similar to Run 541-2A except that the latter was made with internal downcomer, at 3 minutes residence time, with clarifier (only) for dewatering solids and with limestone addition to EHT.	A continuation of the base case limestone Run 590-2A in which external downcomer was used. For this run, internal downcomer was used because external downcomer was frozen.	To observe the effect of the 5000 ppm effective Mg^{++} ion concentration on SO_2 removal and gypsum saturation. Test conditions were the same as Run 590-2A except that limestone was added to EHT and that MgO was added during Run 591-2A. Run 591-2A is similar to Run 543-2B (made in April 1975) except that the latter was made with 3 minutes residence time, with centrifuge, and with internal downcomer.	To observe the effect of the 9000 ppm effective Mg^{++} ion concentration on SO_2 removal and gypsum saturation. Test conditions were the same as Run 591-2A except that the effective Mg^{++} ion concentration was increased from 5000 ppm to 9000 ppm. Run 592-2A is similar to Run 544-2A (made in May 1975) except that the latter was made with internal downcomer and with limestone addition to downcomer.
Results	Gypsum saturation averaged 110% in the scrubber inlet liquor. Sulfite oxidation averaged 43% (steady state oxidation was not reached because of short run duration and high oxidation in previous Run 620-2A). SO_2 removal averaged 68% with an inlet SO_2 concentration of 2100 ppm. The run was terminated due to freezing problems.	Gypsum saturation averaged 123% in the scrubber inlet liquor. Average sulfite oxidation was 33%. SO_2 removal averaged 77% at 2400 ppm average inlet SO_2 concentration. The scrubber was not shutdown at the end of the run. Run terminated and switched to lime operation (Run 724-2A) because of frozen limestone feed line.	Gypsum saturation in the scrubber inlet liquor averaged 105%. Sulfite oxidation averaged 26%. SO_2 removal averaged 92% at 2300 ppm average inlet SO_2 concentration. The effective Mg^{++} ion concentration was 4900 ppm. The mist eliminator was 0.2% restricted at the end of the run. (a) Total alkali stoichiometric ratio (Ca + Mg) is 1.17 - 1.41 (avg. alkali utilization = 77%).	Gypsum saturation in the scrubber inlet liquor averaged 100%. Sulfite oxidation averaged 37%. SO_2 removal averaged 90% at 2400 ppm average inlet SO_2 concentration. The effective Mg^{++} ion concentration was 8900 ppm. The mist eliminator was 2% restricted at the end of the run. (b) Total alkali stoichiometric ratio (Ca + Mg) is 1.31 - 1.49 (avg. alkali utilization = 70%).

Table H-1 (continued)

SUMMARY OF LIMESTONE TESTING WITH MgO ADDITION ON THE TCA SYSTEM

Run Number	593-2A	594-2A	
Start-of-Run Date	4/21/78	5/2/78	
End-of-Run Date	5/2/78	5/6/78	
On Stream Hours	260	99	
Fly Ash Loading	High	High	
MgO Addition	Yes	Yes	
Gas Rate, acfm @ 300°F	30,000	30,000	
Gas Velocity, fps @ 125°F	12.5	12.5	
Liquor Rate, gpm	900	1200	
L/G, gal/Mcf	37	50	
Percent Solids Recirculated	14.0 - 15.6	13.9 - 16.3	
Effluent Residence Time, min.	4.1	4.1	
Stoichiometric Ratio, moles Ca added/mole SO2 absorbed	1.27 - 1.92(a)	1.15 - 1.33(b)	
Avg. % Limestone Utilization, 100 x moles SO2 abs./mole Ca added	63(a)	81(b)	
Inlet O2 Concentration, vol. %	5.6 - 7.2	5.7 - 6.0	
Inlet SO2 Concentration, ppm	2300 - 3400	2200 - 3500	
Percent SO2 Removal	89 - 97	89 - 96	
Avg. SO2 Make-Per-Pass, m-mole/l	18.8	13.8	
Scrubber Inlet pH Range	5.3 - 5.6	5.15 - 5.55	
Scrubber Outlet pH Range	5.0 - 5.4	4.9 - 5.4	
Percent Sulfite Oxidized	10 - 37	10 - 26	
Solids Disposal System	Clarifier & Centrifuge	Clarifier & Centrifugre	
Solids in Sludge Discharged, %	52 - 62	53 - 54	
Calculated Avg. % Gypsum Saturation in Scrubber Inlet Liquor @ 50°C	85	90	
Total Dissolved Solids, ppm	46,300 - 54,300	46,600 - 54,000	
Total ΔP Range Excluding Mist Elimination System, in. H2O	6.6 - 7.8	7.2 - 8.8	
Mist Elimination System ΔP Range, in. H2O	0.49 - 0.66	0.51 - 0.56	
Mist Elimination System Configuration	Three-pass, open-vane, 316L SS chevron mist eliminator.	Three-pass, open-vane, 316L SS chevron mist eliminator.	
Mist Eliminator Washing Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on for 3 min. (0.55 gpm/sq.ft.) with 7 min. off between nozzles. Bottom washed intermittently with makeup water. The nozzles (2 total) were on for 4 min. each hour (1.5 gpm/sq.ft.)	Top washed sequentially with makeup water. Each nozzle (6 total) on for 3 min. (0.55 gpm/sq.ft.) with 7 min. off between nozzles. Bottom washed interrittently with makeup water. The nozzles (2 total) were on for 4 min. each hour (1.5 gpm/sq.ft.).	
Absorbent	Limestone slurried to 60 wt% with makeup water and added to EHT. MgO dry fed to EHT.	Limestone slurried to 60 wt with makeup water and added to EHT. MgO dry fed to EHT.	
Scrubber Internals	Three beds (4 grids) with nominally 5 inches/bed of nitrile foam spheres from Run 592-2A.	Three beds (4 grids) with nominally 5 inches/bed of nitrile foam spheres from Run 593-2A.	
System Changes Before Start of Run	No changes. No cleaning.	Cleaned Hauck reheater shell and I.D. fan damper. No other changes.	
Method of Control	Limestone stoichiometric ratio controlled at 1.2. Effective Mg++ ion concentration (total ppm Mg++ - ppm Cl^-/2.92) controlled at 9000 ppm. Hold tank (D-204) with external downcomer was used.	Limestone stoichiometric ratio controlled at 1.2. Effective Mg++ ion concentration (total ppm Mg++ - ppm Cl^-/2.92) controlled at 9000 ppm. Hold tank (D-204) with internal downcomer was used.	
Run Philosophy	To observe the effect of the 9000 ppm effective Mg++ ion concentration on SO2 removal and gypsum saturation. Test conditions were the same as Run 592-2A except that the EHT level was lowered to 12'-10" from 17'-0" and the liquor rate was reduced to 900 gpm from 1200 gpm. Run 593-2A is similar to Run 585-2A (made in May 1976) except that the latter was made with internal downcomer, with clarifier only and with limestone addition to the downcomer.	To observe the effect of the 9000 ppm effective Mg++ ion concentration on SO2 removal and gypsum saturation. Test conditions were the same as Run 592-2A except that the internal downcomer was used. The purpose of the run was to observe if it could be operated in the gypsum unsaturated mode.	
Results	Gypsum saturation in the scrubber inlet liquor averaged 85%. Sulfite oxidation averaged 24%. SO2 removal averaged 93% at 2850 ppm average inlet SO2 concentration. The effective Mg++ ion concentration was 9000 ppm. The mist eliminator was 1% restricted at the end of the run. (a) Total stoich. ratio for Ca & Mg is 1.36-2.01 (avg. alkali utilization = 59%.).	Gypsum saturation in the scrubber inlet liquor averaged 93%. Sulfite oxidation averaged 18%. SO2 removal averaged 93% at 2850 ppm average inlet SO2 concentration. The effective Mg++ ion concentration was 8950 ppm. The mist eliminator was 1% restricted at the end of the run. (b) Total stoich. ratio for Ca & Mg is 1.24-1.42 (avg. alkali utilization = 75%).	

Table H-2

SUMMARY OF LIME TESTING WITH MgO ADDITION ON THE TCA SYSTEM

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	Clarifier + Centrifuge	Clarifier + Centrifuge	Clarifier + Centrifuge	Clarifier + Centrifuge
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	No changes. No cleaning.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
			[illegible]	[illegible]

Table H-2 (continued)

SUMMARY OF LIME TESTING WITH MgO ADDITION ON THE TCA SYSTEM

Run Number	[illegible]	[illegible]	[illegible]	[illegible]
Start-of-Run Date	3/17/78	[illegible]	5/12/78	6/19/78
End-of-Run Date	3/27/78	3/22/78	5/19/78	[illegible]
On Stream Hours	239	[illegible]	125	151
Fly Ash Loading	High	High	High	High
MgO Addition	Yes	Yes	Yes	Yes
Gas Rate, acfm @ 300°F	30,000	35,000	35,000	30,000
Gas Velocity, fps @ 125°F	12.5	12.5	12.5	12.5
Liquor Rate, gpm	1200	800	800	1200
L/G, gal/Mcf	55	47	47	55
Percent Solids Recirculated	[illegible]	[illegible]	7.2 - 8.7	7.4 - 9.0
Effluent Residence Time, min.	3.3	4.5	4.1	3.0
Stoichiometric Ratio, moles Ca added/mole SO_2 absorbed	0.94 - 1.08[a]	0.99 - 1.04[b]	0.97 - 1.12[c]	1.01 - 1.11[d]
Avg. % Lime Utilization, 100 x moles SO_2 abs./mole Ca added	98[a]	99[b]	91[c]	96[d]
Inlet O_2 Concentration, vol. %	7.4 - 10.5	7.8 - 9.5	6.2 - 8.1	7.2 - 9.5
Inlet SO_2 Concentration, ppm	800 - 1100	2100 - 3100	2200 - 4000	2200 - 2800
Percent SO_2 Removal	93 - 99	85 - 98	80 - 90	80 - 91
Avg. SO_2 Make Per Pass, mmole/l	18.5	23.4	15.5	15.1
Scrubber Inlet pH Range	6.8 - 7.1	6.7 - 7.2	5.85 - 7.08	6.7 - 7.4
Scrubber Outlet pH Range	5.15 - 6.15	5.2 - 6.1	5.2 - 5.9	5.0 - 5.4
Percent Sulfite Oxidized	[illegible]	12 - 28	13 - 17	[illegible] - 22
Solids Disposal System	Clarifier & Centrifuge	Clarif./Clarif. & Centrifuge	Clarif./Clarif. & Centrifuge	Clarifier & Centrifuge
Solids in Sludge Discharged, %	48 - 62	[illegible]	[illegible]	55 - 68
Calculated Avg. % Gypsum Saturation in Scrubber Inlet Liquor @ 50°C	116	88	95	51
Total Dissolved Solids, ppm	13,400 - 17,300	18,000 - 34,200	13,285 - 16,985	12,900 - 16,700
Total ΔP Range Excluding Mist Elimination System, in. H_2O	9.1 - 12.1	6.1 - 7.8	6.8 - 7.2	6.4 - 7.6
Mist Elimination System ΔP Range, in. H_2O	0.48 - 0.64	0.50 - 0.66	0.42 - 0.49	0.36 - 0.48
Mist Elimination System Configuration	Three pass, open vane, 316L SS chevron mist eliminator.	Three pass, open vane, 316L SS chevron mist eliminator.	Three pass, open vane, 316L SS chevron mist eliminator.	Three pass, open vane, 316L SS chevron mist eliminator.
Mist Eliminator Washing Scheme	Top washed sequentially with makeup water. Each nozzle (8 total) on for 4 min. (0.38 gpm/sq.ft.) with 7½ min. off between nozzles. Bottom washed intermittently with makeup water. The nozzles (2 total) were on for 5 min. every 4 hours (1.5 gpm/sq.ft.).	Top washed sequentially with makeup water. Each nozzle (8 total) on for 4 min. (0.38 gpm/sq.ft.) with 7½ min. off between nozzles. Bottom washed intermittently with makeup water. The nozzles (2 total) were on for 5 min. every 4 hours (1.5 gpm/sq.ft.).	Top washed sequentially with makeup water. Each nozzle (8 total) on for 4 min. (0.38 gpm/sq.ft.) with 7½ min. off between nozzles. Bottom washed intermittently with makeup water. The nozzles (2 total) were on for 5 min. every 4 hours (1.5 gpm/sq.ft.).	Top washed sequentially with makeup water. Each nozzle (8 total) on for 4 min. (0.38 gpm/sq.ft.) with 7½ min. off between nozzles. Bottom washed intermittently with makeup water. The nozzles (2 total) were on for 5 min. every 4 hours (1.5 gpm/sq.ft.).
Absorbent	Lime slaked to a 20 wt% slurry with makeup water and added to the downcomer. MgO dry fed to EHT.	Lime slaked to a 20 wt% slurry with makeup water and added to EHT. MgO dry fed to EHT.	Lime slaked to a 20 wt% slurry with makeup water and added to downcomer. MgO dry fed to EHT.	Lime slaked to a 20 wt% slurry with makeup water and added to downcomer. MgO dry fed to EHT.
Scrubber Internals	Three beds (4 grids) with nominally 5 inches/bed of nitrile foam spheres from Run [illegible]. Actual measured bed height was 13 inches total at the end of the run.	Three beds (4 grids) with nominally 5 inches/bed of nitrile foam spheres from Run [illegible].	Three beds (4 grids) with nominally 5 inches/bed of nitrile foam spheres from Run [illegible].	Three beds (4 grids) with nominally 5 inches/bed of nitrile foam spheres from Run [illegible]. Actual measured total bed height was 15.5 inches at the end of the run.
System Changes Before Start of Run	Cleaned [illegible] and outlet duct. No other changes.	Cleaned I.D. fan and damper. Switched from limestone to lime. No other changes.	(No shutdown.)	(No shutdown.)
Method of Control	Scrubber inlet pH controlled at 7.0 ± 0.2. Effective liquor Mg^{++} ion concentration (total ppm Mg^{++} - ppm Cl^-/2.92) controlled at 2000 ppm. Hold tank (D-208) with external downcomer was used.	Scrubber inlet pH controlled at 7.0 ± 0.2. Effective liquor Mg^{++} ion concentration (total ppm Mg^{++} - ppm Cl^-/2.92) controlled at 2000 ppm. Hold tank (D-208) with external downcomer was used.	Scrubber inlet pH controlled at 7.0 ± 0.2. Effective liquor Mg^{++} ion concentration (total ppm Mg^{++} - ppm Cl^-/2.92) controlled at 2000 ppm. Hold tank (D-208) with external downcomer was used.	Scrubber inlet pH controlled at 7.0 ± 0.2. Effective liquor Mg^{++} ion concentration (total ppm Mg^{++} - ppm Cl^-/2.92) controlled at 2000 ppm. Hold tank (D-208) with external downcomer was used.
Run Philosophy	To observe the effect of the 2000 ppm effective Mg^{++} ion concentration on SO_2 removal and gypsum saturation. Test conditions were the same as Run [illegible] except the residence time was reduced to 3.3 min. from 4.1 min. and the liquor rate was increased to 1200 gpm from 800 gpm. (Run [illegible] is identical to Run [illegible] except that the hold tank (D-208) with internal downcomer was used in the latter run.)	To observe the effect of the 2000 ppm effective Mg^{++} ion concentration on SO_2 removal and gypsum saturation. Test conditions were the same as Run [illegible] except lime was added to EHT. The purpose of the run was to compare the results with those of Run [illegible] during which the inlet SO_2 concentration was very low and gypsum unsaturated operation was not achieved.	To observe the effect of the 2000 ppm effective Mg^{++} ion concentration on SO_2 removal and gypsum saturation. Test conditions were the same as Run [illegible]. The purpose of the run was to compare the results with those of Run [illegible] during which the inlet SO_2 concentration was very low and gypsum unsaturated operation was not achieved.	To observe the effect of the 2000 ppm effective Mg^{++} ion concentration on SO_2 removal and gypsum saturation. Test conditions were the same as Run [illegible]. The purpose of the run was to compare the results with those of Run [illegible] during which the inlet SO_2 concentration was very low and gypsum unsaturated operation was not achieved.
Results	Gypsum saturation in scrubber inlet liquor averaged 116%. Average sulfite oxidation was [illegible]. SO_2 removal averaged [illegible] at [illegible] ppm average inlet SO_2 concentration. The effective Mg^{++} ion concentration was [illegible] ppm. The mist eliminator was [illegible] at the end of the run. (a) Total stoich. ratio for Ca + Mg is [illegible] (avg. alkali utilization = [illegible]).	Gypsum saturation in the scrubber inlet liquor averaged 88%. Sulfite oxidation averaged [illegible]. SO_2 removal averaged [illegible] at [illegible] ppm average inlet SO_2 concentration. The effective Mg^{++} ion concentration was [illegible] ppm. The scrubber was not shutdown at the end of the run. Steady state Mg^{++} ion concentration was not reached for the run. (b) Total stoich. ratio for Ca + Mg is [illegible] (avg. alkali utilization = [illegible]).	Gypsum saturation in the scrubber inlet liquor averaged 95%. Sulfite oxidation averaged [illegible]. SO_2 removal averaged [illegible] at [illegible] ppm average inlet SO_2 concentration. The effective Mg^{++} ion concentration was [illegible] ppm. The scrubber was not shut down at the end of the run. (c) Total stoich. ratio for Ca + Mg is [illegible] (avg. alkali utilization = [illegible]).	Gypsum saturation in the scrubber inlet liquor averaged 51%. Sulfite oxidation averaged [illegible]. SO_2 removal averaged [illegible] at [illegible] ppm average inlet SO_2 concentration. The effective Mg^{++} ion concentration was [illegible] ppm. The mist eliminator was [illegible] at the end of the run. (d) Total stoich. ratio for Ca + Mg is [illegible] (avg. alkali utilization = [illegible]).

Table H-2 (continued)

SUMMARY OF LIME TESTING WITH MgO ADDITION ON THE TCA SYSTEM

Run Number	[illegible]	
Start-of-Run Date	[illegible]	
End-of-Run Date	[illegible]	
On-Stream Hours	283	
Fly Ash Loading	High	
MgO Addition	Yes	
Gas Rate, acfm @ 330°F	30,000	
Gas Velocity, fps @ 125°F	12.5	
Liquor Rate, gpm	900	
L/G, gal/Mcf	37	
Percent Solids Recirculated	7.6 - 9.6	
Effluent Residence Time, min	5.0	
Stoichiometric Ratio, moles Ca added/mole SO_2 absorbed	1.00 - 1.04(a)	
Avg. % Lime Utilization, 100x moles SO_2 abs./mole Ca added	98(a)	
Inlet CO_2 Concentration, vol %	11.6 - 12.5	
Inlet SO_2 Concentration, ppm	2400 - 3450	
Percent SO_2 Removal	75 - 86	
Avg. SO_2 Make-Per-Pass, m-mole/l	16.9	
Scrubber Inlet pH Range	6.7 - 7.2	
Scrubber Outlet pH Range	4.9 - 5.6	
Percent Sulfite Oxidized	6 - 22	
Solids Disposal System	Clarifier	
Solids in Sludge Discharged, %	35 - 44	
Calculated Avg. % Gypsum Saturation in Scrubber Inlet Liquor @ 50°C	65	
Total Dissolved Solids, ppm	11,900 - 15,500	
Total ΔP Range Excluding Mist Elimination System, in. H_2O	5.6 - 7.0	
Mist Elimination System ΔP Range, in. H_2O	0.43 - 0.73	
Mist Elimination System Configuration	Three-pass, open-vane, 316L SS chevron mist eliminator	
Mist Eliminator Washing Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on for 4 min. (0.55 gpm/sq.ft.) with 76 min. off (or fewer nozzles). Bottom washed intermittently with makeup water. The nozzles (7 total) were on for 6 min. every 4 hours (1.5 gpm/sq.ft.).	
Absorbent	Lime slaked to a 20 wt% slurry with makeup water and added to the downcomer. MgO dry fed to EHT.	
Scrubber Internals	Three beds (4 grids) with nominally 5 inches/bed of nitrile foam spheres from Run 621-2A. Actual measured bed height was 13 inches total at the end of the run.	
System Changes Before Start of Run	Cleaned crossover line. Switched from limestone to lime. No other changes.	
Method of Control	Scrubber inlet pH controlled at 7.0 ± 0.2. Effective liquor Mg^{++} ion concentration (total ppm Mg^{++} - ppm Cl^-/2.92) controlled at 2000 ppm. Hold tank (D-204) with external downcomer was used.	
Run Philosophy	The purpose of this run was to see what effect the lowering of the EHT residence time had on sulfate saturation (cf. Run 620-1A).	
Results	Gypsum saturation in the scrubber inlet liquor averaged 65%. Sulfite oxidation averaged 15%. SO_2 removal averaged 82% at 2900 ppm average inlet SO_2 concentration. The effective Mg^{++} ion concentration was 1950 ppm. The mist eliminator was 12% restricted at the end of the run. (a) Total stoich. ratio for Ca & Mg is 1.00-1.06 (avg. alkali utilization = 97%).	

Table H-3

SUMMARY OF LIMESTONE TESTS WITH LOW FLY ASH LOADING ON THE TCA SYSTEM

Run Number	701-2A	702-2A	703-2A	704-2A
Start-of-Run Date	11/24/76	12/ 6/76	12/13/76	12/21/76
End-of-Run Date	12/ 6/76	12/13/76	12/20/76	1/ 4/77
On Stream Hours	277	163	153	124
Gas Rate, acfm @ 300°F	30,000	30,000	30,000	30,000
Gas Velocity, fps @ 125°F	12.5	12.5	12.5	12.5
Liquor Rate, gpm	1200	1200	1200	1200
L/G, gal/mcf	50	50	50	50
Percent Solids Recirculated	7.5 - 8.5	14.3 - 16.1	7.5 - 8.2	7.1 - 8.9
Effluent Residence Time, min.	4.1	4.1	4.2	12.3 (3 tanks)
Stoichiometric Ratio, moles Ca added/mole SO_2 absorbed	1.14 - 1.28	1.07 - 1.24	1.06 - 1.18	1.07 - 1.17
Avg. % Limestone Utilization, 100x moles SO_2 abs./mole Ca added	83	86	90	91
Inlet SO_2 Concentration, ppm	2100 - 3300	2600 - 3400	2600 - 3300	2200 - 3200
Percent SO_2 Removal	81 - 92	74 - 88	66 - 82	68 - 86
Scrubber Inlet pH Range	5.55 - 6.0	5.6 - 6.1	5.5 - 5.85	5.4 - 5.95
Scrubber Outlet pH Range	5.0 - 5.4	5.0 - 5.5	4.9 - 5.3	4.8 - 5.2
Inlet O_2 Concentration, vol. %	7.5 - 10	8 - 10.5	7.5 - 9.5	8 - 10.5
Percent Sulfur Oxidized	2 - 22	1 - 13	1 - 13	2 - 26
Solids Disposal System	Clarifier & Centrifuge	Cent. (till 12/10)/ Clarifier	Clarifier & Centrifuge	Clarifier & Centrifuge
Loop Closure, % Solids Dischg.	31 - 43[(a)]	33 - 42[(b)]	41 - 55[(c)]	40 - 46[(d)]
Calculated Avg % Sulfate Saturation in Scrubber Inlet Liquor @ 50°C	45	20	25	65
Total Dissolved Solids, ppm	6600 - 7800	3400 - 6600	4600 - 6800	5000 - 9000
Total ΔP Range Excluding Mist Elimination System, in. H_2O	7.7 - 9.1	7.5 - 8.0	6.9 - 7.6	7.0 - 9.0
Mist Elimination System ΔP Range, in. H_2O	0.42 - 0.56	0.45 - 0.50	0.43 - 0.49	0.40 - 0.56
Mist Elimination System Configuration	3-pass, open-vane, 316L SS chevron mist eliminator.	3-pass, open-vane, 316L SS chevron mist eliminator.	3-pass, open-vane, 316L SS chevron mist eliminator.	3-pass, open-vane, 316L SS chevron mist eliminator.
Absorbent	Limestone slurried to 60 wt.% with makeup water and added to EHT.	Limestone slurried to 60 wt.% with makeup water and added to EHT.	Limestone slurried to 60 wt.% with makeup water and added to EHT.	Limestone slurried to 60 wt.% with makeup water and added to EHT.
Mist Eliminator Washing Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 minutes (at 0.55 gpm/sq. ft.) with 7 minutes off between nozzles. Bottom washed intermittently with makeup water at 1.5 gpm/sq. ft. for 4 minutes every hour.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 minutes (at 0.55 gpm/sq. ft.) with 7 minutes off between nozzles. Bottom washed intermittently with makeup water at 1.5 gpm/sq. ft. for 4 minutes every hour.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 minutes (at 0.55 gpm/sq. ft.) with 7 minutes off between nozzles. Bottom washed intermittently with makeup water at 1.5 gpm/sq. ft. for 4 minutes every hour.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 minutes (at 0.55 gpm/sq. ft.) with 7 minutes off between nozzles. Bottom washed intermittently with makeup water at 1.5 gpm/sq. ft. for 4 minutes every hour.
Scrubber Internals	3 beds (4 grids) with nominal 5 inches spheres/bed. Bottom two beds worn nitrile foam spheres from Run 617-2A. Top bed 5 in. new nitrile foam spheres. Total actual bed height estimated to be 15 inches	3 beds (4 grids) with nominal 5 inches spheres/bed. All beds worn nitrile foam spheres from previous run. Estimated total actual bed height was 14 inches.	3 beds (4 grids) with nominal 5 inches spheres/bed. All beds worn nitrile foam spheres from previous run. Estimated total actual bed height was 13 inches.	3 beds (4 grids) with nominal 5 inches spheres/bed. All beds worn nitrile foam spheres from previous run. Estimated total actual bed height was 12 inches.
System Changes Before Start of Run	Scrubber system cleaned. Clarifier dumped.	Mist eliminator cleaned. No other changes.	Mist eliminator cleaned. No other changes.	No cleaning. No changes.
Method of Control	Stoichiometric ratio controlled at 1.2 moles Ca/mole SO_2 absorbed.	Stoichiometric ratio controlled at 1.2 moles Ca/mole SO_2 absorbed.	Stoichiometric ratio controlled at 1.1 moles Ca/mole SO_2 absorbed.	Stoichiometric ratio controlled at 1.1 moles Ca/mole SO_2 absorbed.
Run Philosophy	To observe the performance of the TCA when scrubbing fly ash-free flue gas with limestone. This is the first TCA fly ash-free limestone run of this series.	To observe the effect of the higher percent solids recirculated (15% cf. with 8% for Run 701-2A) on pH and SO_2 removal. All other test conditions same as for Run 701-2A.	To observe the effect of a lower stoichiometric ratio (1.1 cf. 1.2 for Run 701-2A) on sulfite scaling, mist eliminator reliability and SO_2 removable. All other conditions the same as for Run 701-2A.	To observe the effect of three-tanks-in-series operation on pH at a 1.1 stoichiometric ratio. All test conditions, other than residence time and tank configuration, same as for Run 703-2A.
Results	SO_2 removal averaged 87% and limestone utilization 83% at an average SO_2 inlet concentration of 2700 ppm. Sulfate saturation averaged 45%. Some calcium sulfite scale formed in lower part of TCA. The mist eliminator was 25% restricted at the end of the run. (a) Percent solids discharged adjusted for clarified liquor leaking from system. Centrifuge cake solids 44 - 52%.	Scrubber inlet pH averaged 5.85 (cf. 5.80 for Run 701-2A). The SO_2 removal averaged 81% and limestone utilization 86% at an average inlet SO_2 concentration of 3000 ppm. The mist eliminator was 10% restricted at the end of the run. No sulfite scaling. (b) Percent solids discharged adjusted for clarified liquor leaking from system. Centrifuge cake solids 52 - 64%. Clarifier underflow solids ~ 36%.	SO_2 removal averaged 74% and limestone utilization 90% at an average inlet SO_2 concentration of 2960 ppm (cf. 87%, 83%, and 2700 ppm for Run 701-2A). Sulfate saturation averaged 25%, and the mist eliminator was 1% restricted at the end of the run. No sulfite scaling. (c) Adjusted for excess clarified liquor discharged. Centrifuge cake solids 47 - 61%.	The scrubber inlet liquor pH averaged 5.7 (cf. 5.55 for Run 703-2A). SO_2 removal averaged 77% and limestone utilization 91% at an average inlet SO_2 concentration of 2700 ppm (cf. 74%, 90%, and 2960 ppm for Run 703-2A). The mist eliminator was 1% restricted at the end of the run. (d) Adjusted for excess clarified liquor discharged. Centrifuge cake solids 45 - 51%.

Table H-3 (continued)

SUMMARY OF LIMESTONE TESTS WITH LOW FLY ASH LOADING ON THE TCA SYSTEM

Run Number	705-2A	706-2A
Start-of-Run Date	1/4/77	1/14/77
End-of-Run Date	1/14/77	2/4/77
On Stream Hours	236	339
Fly Ash	No	No
MgO Addition	No	No
Gas Rate, acfm @ 300°F	30,000	30,000
Gas Velocity, fps @ 125°F	12.5	12.5
Liquor Rate, gpm	1200	1200
L/G, gal/Mcf	50	50
Percent Solids Recirculated	14.4 - 15.4	13.8 - 15.5
Effluent Residence Time, min	12 (3 tanks)	12
Stoichiometric Ratio, moles Ca added/mole SO_2 absorbed	1.05 - 1.18	1.05 - 1.2
Avg. % Limestone Utilization, 100 x moles SO_2 abs./mole Ca added	90	89
Inlet SO_2 Concentration, ppm	2500 - 3200	2400 - 3300
Percent SO_2 Removal	80 - 88	74 - 88
Scrubber Inlet pH Range	5.75 - 5.95	5.4 - 5.7
Scrubber Outlet pH Range	5.1 - 5.35	4.9 - 5.15
Inlet O_2 Concentration, vol. %	9 - 12	9 - 12
Percent Sulfite Oxidized	4 - 17	10 - 26
Solids Disposal System	Clarifier	Clarifier
Loop Closure, % Solids Dischg	32 - 40	33 - 41
Calculated Avg. % Sulfate Saturation in Scrubber Inlet Liquor @ 50°C	60	125
Total Dissolved Solids, ppm	6400 - 8100	7200 - 9600
Total ΔP Range Excluding Mist Elimination System, in. H_2O	8.5 - 9.7	7.7 - 10.4
Mist Elimination System ΔP Range, in. H_2O	0.41 - 0.52	0.44 - 0.55
Mist Elimination System Configuration	3-pass, open-vane, 316L SS chevron mist eliminator	3-pass, open-vane, 316L SS chevron mist eliminator.
Absorbent	Limestone slurried to 60 wt % with makeup water and added to first tank in series	Limestone slurried to 60 wt % with makeup water and added to EHT.
Mist Eliminator Washing Scheme	Top washed sequentially with makeup water. Each nozzle (4 total) on 3 minutes (at 0.55 gpm/sq. ft.) with 7 minutes off between nozzles. Bottom washed intermittently with makeup water at 1.5 gpm/sq. ft. for 4 minutes every hour.	Top washed sequentially with makeup water. Each nozzle (4 total) on 3 minutes (at 0.55 gpm/sq. ft.) with 7 minutes off between nozzles. Bottom washed intermittently with makeup water at 1.5 gpm/sq. ft. for 4 minutes every hour.
Scrubber Internals	3 beds (4 grids) with nominal 5 inches spheres/bed. All beds worn nitrile foam spheres from Run 704-2A plus other used spheres in bottom two beds. Total actual bed ht. estimated to be 15-1/2 inches.	3 beds (4 grids) with nominal 5 inches spheres/bed. All beds worn nitrile foam spheres from Run 705-2A.
System Changes Before Start of Run	No cleaning. Added 1500 used nitrile foam spheres to each of middle and bottom beds.	No cleaning. No changes.
Method of Control	Stoichiometric Ratio controlled at 1.1 moles Ca/mole SO_2 absorbed.	Stoichiometric Ratio controlled at 1.1 moles Ca/mole SO_2 absorbed.
Run Philosophy	To observe the effect of the higher 15% solids recirculated (cf. 8% for Run 704-2A) on scrubber inlet pH and SO_2 removal.	To observe the effect of single-tank operation on pH, stoichiometry and SO_2 removal compared with three-tank operation during Run 705-2A. All other conditions the same.
Results	The scrubber inlet pH averaged 5.85 (cf. 5.7 for Run 704-2A). SO_2 removal averaged 84% (cf. 77% for Run 704-2A). The mist eliminator was 1% restricted at the end of the run.	The scrubber inlet pH averaged 5.55 (cf. 5.85 for Run 705-2A), and SO_2 removal averaged 81% (cf. 84% for Run 705-2A). Stoich. ratios were approx. the same for Runs 705-2A and 706-2A (90% and 89%, respectively). Mist eliminator was cleaned (8% restricted) after 115 operating hours to allow outlet particulate sampling. It was 1% restricted at the end of the run.

Table H-4

SUMMARY OF LIMESTONE GRIND AND TYPE TESTS ON THE TCA SYSTEM

Run Number	707-2A	708-2A	709-2A	710-2A
Start-of-Run Date	3/4/77	3/ 9/77	3/15/77	3/17/77
End-of-Run Date	3/9/77	3/14/77	3/17/77	3/24/77
On Stream Hours	113	128	56	162
Fly Ash	Yes	Yes	Yes	Yes
MgO Addition	No	No	No	No
Gas Rate, acfm @ 300°F	30,000	30,000	30,000	30,000
Gas Velocity, fps @ 125°F	12.5	12.5	12.5	12.5
Liquor Rate, gpm	1200	1200	1200	1200
L/G, gal/Mcf	50	50	50	50
Percent Solids Recirculated	13.5 - 15.5	14.6 - 15.9	13.1 - 14.9	14.3 - 15.1
Effluent Residence Time, min	4.1	4.1	4.1	12
Stoichiometric Ratio, moles Ca added/mole SO_2 absorbed	1.16 - 1.30	1.08 - 1.22	1.08 - 1.28	1.15 - 1.32
Avg. % Limestone Utilization, 100x moles SO_2 abs./mole Ca added	81	87	85	81
Inlet SO_2 Concentration, ppm	2700 - 3500	2750 - 3400	3000 - 3650	2900 - 3900
Percent SO_2 Removal	66 - 77	42 - 56	48 - 61	48 - 60
Scrubber Inlet pH Range	5.4 - 5.8	5.0 - 5.4	5.1 - 5.5	5.2 - 5.6
Scrubber Outlet pH Range	5.1 - 5.3	4.7 - 5.1	4.9 - 5.1	4.6 - 5.2
Inlet O_2 Concentration, vol. %	6 - 11	5.8 - 8.2	8.0 - 8.6	5.3 - 7.7
Percent Sulfite Oxidized	13 - 20	8 - 20	10 - 30	8 - 24
Solids Disposal System	Clarifier	Clarifier	Clarifier	Clarifier
Solids in Sludge Discharged, %	38 - 42	37 - 43	37 - 41	38 - 48
Calculated Avg. % Gypsum Sat'n. in Scrubber Inlet Liquor @ 50°C	100	115	110	110
Total Dissolved Solids, ppm	5800 - 8200	6200 - 6960	5500 - 6400	6200 - 6800
Total ΔP Range Exluding Mist Elimination System, in. H_2O	6.0 - 7.2	5.8 - 8.2	6.0 - 6.7	6.0 - 6.7
Mist Elimination System ΔP Range, in. H_2O	0.45 - 0.57	0.44 - 0.49	0.44 - 0.49	0.47 - 0.55
Mist Elimination System Configuration	3-pass, open-vane, 316L SS chevron mist eliminator.	3-pass, open-vane, 316L SS chevron mist eliminator.	3-pass, open-vane, 316L SS chevron mist eliminator.	3-pass, open-vane, 316L SS chevron mist eliminator.
Absorbent	Fine Fredonia White limestone (96% < 325 mesh) slurried to 60 wt% with makeup water and added to EHT.	Coarse Fredonia White limestone (69% < 325 mesh) slurried to 60 wt% with makeup water and added to EHT.	Coarse Longview, Ala. limestone (65% < 325 mesh) slurried to 60 wt% with makeup water and added to EHT.	Coarse Fredonia White limestone (69% < 325 mesh) slurried to 60 wt% with makeup water and added to EHT.
Mist Eliminator Washing Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 minutes (at 0.55 gpm/sq. ft.) with 7 minutes off between nozzles. Bottom washed intermittently with makeup water at 1.5 gpm/sq. ft. for 4 minutes every hour.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 minutes (at 0.55 gpm/sq. ft.) with 7 minutes off between nozzles. Bottom washed intermittently with makeup water at 1.5 gpm/sq. ft. for 4 minutes every hour.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 minutes (at 0.55 gpm/sq. ft.) with 7 minutes off between nozzles. Bottom washed intermittently with makeup water at 1.5 gpm/sq. ft. for 4 minutes every hour.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 minutes (at 0.55 gpm/sq. ft.) with 7 minutes off between nozzles. Bottom washed intermittently with makeup water at 1.5 gpm/sq. ft. for 4 minutes every hour.
Scrubber Internals	3 beds (4 grids) with nominal 5 inches spheres/bed. All beds worn nitrile foam spheres from Run TFG-2A. Total actual bed ht. estimated to be 15 inches.	3 beds (4 grids) with nominal 5 inches spheres/bed. All beds worn nitrile foam spheres from previous run. Total actual bed ht. estimated to be 15 inches.	3 beds (4 grids) with nominal 5 inches spheres/bed. All beds worn nitrile foam spheres from previous run. Total actual bed ht. estimated to be 15 inches.	3 beds (4 grids) with nominal 5 inches spheres/bed. All beds worn nitrile foam spheres from previous run. Total actual bed ht. estimated to be 15 inches.
System Changes Before Start of Run	Scrubber was cleaned. Mist eliminator was not cleaned.	Mist eliminator was cleaned. No other changes.	(No shutdown	No cleaning. No changes.
Method of Control	Stoichiometric ratio controlled at 1.2 moles Ca/mole SO_2 absorbed.	Stoichiometric ratio controlled at 1.2 moles Ca/mole SO_2 absorbed.	Stoichiometric ratio controlled at 1.2 moles Ca/mole SO_2 absorbed.	Stoichiometric ratio controlled at 1.2 moles Ca/mole SO_2 absorbed.
Run Philosophy	To establish a base case using the standard limestone type and grind used to-date at Shawnee for comparison with the other limestone types and/or grinds.	To observe the effect of a larger limestone grind (69% < 325 mesh vs. 96% < 325 mesh for Run 707-2A) on pH and SO_2 removal. Operating conditions same as for Run 707-2A.	To observe the effect of a different type of limestone (Longview, Ala.) on pH and SO_2 removal. Operating conditions same as for Run 708-2A	To observe the effect of a longer residence time in the effluent hold tank on the coarse Fredonia limestone (cf. Run 708-2A). All other operating conditions same as for Run 708-2A.
Results	SO_2 removal averaged 72% and limestone utilization 81%. The average gypsum saturation was 100%. The mist eliminator was 8% restricted	The coarser Fredonia limestone used in this run yielded 49% SO_2 removal with 87% limestone utilization and 115% gypsum saturation (cf. 72, 81, and 100%, respectively, for Run 707-2A). The mist eliminator was about 1% restricted.	The Longview limestone had an average SO_2 removal of 55% at a limestone utilization of 85% and a gypsum saturation of 110% (cf. 49, 87, and 115%, respectively, for Run 708-2A which used a comparable grind of the Fredonia limestone). Mist eliminator was less than 2% restricted. The run was terminated prematurely due to severe limestone feed line plugging problems.	This run averaged 54% SO_2 removal, 81% limestone utilization and 110% gypsum saturation (cf. 49, 87 and 115%, respectively, for Run 708-2A). The mist eliminator was 4% restricted at the end of the run.

Table H-4 (continued)

SUMMARY OF LIMESTONE GRIND AND TYPE TESTS ON THE TCA SYSTEM

Run Number	711-2A	712-2A	
Start-of-Run Date	3/24/77	3/28/77	
End-of-Run Date	3/28/77	4/ 2/77	
On Stream Hours	93	117	
Fly Ash	Yes	Yes	
MgO Addition	No	No	
Gas Rate, acfm @ 300°F	35,000	35,000	
Gas Velocity, fps @ 125°F	12.5	12.5	
Liquor Rate, gpm	1200	1200	
L/G, gal/Mcf	50	50	
Percent Solids Recirculated	13.8 - 15.1	13 - 16	
Effluent Residence Time, min.	12	12 (3 tanks)	
Stoichiometric Ratio, moles Ca added/mole SO_2 absorbed	1.17 - 1.33	1.16 - 1.26	
Avg. % Limestone Utilization, 100x moles SO_2 abs./mole Ca added	80	83	
Inlet SO_2 Concentration, ppm	2900 - 3600	2750 - 3350	
Percent SO_2 Removal	58 - 69	64 - 74	
Scrubber Inlet pH Range	5.4 - 5.85	5.7 - 6.0	
Scrubber Outlet pH Range	4.8 - 5.1	5.0 - 5.4	
Inlet O_2 Concentration, vol. %	--	5.7 - 7.5	
Percent Sulfite Oxidized	10 - 20	10 - 26	
Solids Disposal System	Clarifier	Clarifier	
Solids in Sludge Discharged, %	35 - 40	36 - 43	
Calculated Avg. % Gypsum Sat'n. in Scrubber Inlet Liquor @ 50°C	80	60	
Total Dissolved Solids, ppm	5000 - 6400	3600 - 6000	
Total ΔP Range Excluding Mist Elimination System, in. H_2O	6.3 - 6.8	6.2 - 7.2	
Mist Elimination System ΔP Range, in. H_2O	0.50 - 0.62	0.48 - 0.61	
Mist Elimination System Configuration	3-pass, open-vane, 316L SS chevron mist eliminator.	3-pass, open-vane, 316L SS chevron mist eliminator.	
Absorbent	Fine Fredonia White limestone (96% < 325 mesh) slurried to 60 wt% with makeup water and added to EHT.	Fine Fredonia White limestone (96% < 325 mesh) slurried to 60 wt% with makeup water and added to first EHT.	
Mist Eliminator Washing Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 minutes (at 0.55 gpm/sq. ft.) with 7 minutes off between nozzles. Bottom washed intermittently with makeup water at 1.5 gpm/sq. ft. for 4 minutes every hour.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 minutes (at 0.55 gpm/sq. ft.) with 7 minutes off between nozzles. Bottom washed intermittently with makeup water at 1.5 gpm/sq. ft. for 4 minutes every hour.	
Scrubber Internals	3 beds (4 grids) with nominal 5 inches spheres/bed. All beds worn nitrile foam spheres from previous run. Total actual bed ht. estimated to be 15 inches.	3 beds (4 grids) with nominal 5 inches spheres/bed. All beds worn nitrile foam spheres from previous run. Total actual bed ht. estimated to be 15 inches.	
System Changes Before Start of Run	No cleaning. No changes.	The mist eliminator was cleaned. No other changes.	
Method of Control	Stoichiometric ratio controlled at 1.2 moles Ca/mole SO_2 absorbed.	Stoichiometric ratio controlled at 1.2 moles Ca/mole SO_2 absorbed.	
Run Philosophy	To observe the effect of a finer limestone grind on pH and SO_2 removal in comparison with Run 710-2A. Operating conditions same as for Run 710-2A.	To observe whether higher SO_2 removal and higher scrubber inlet pH could be achieved with three tanks in series versus a single tank for Run 711-2A. Other test conditions same as for Run 711-2A.	
Results	An average SO_2 removal of 64% with 80% limestone utilization and 80% gypsum saturation resulted with the finer limestone (cf. 54, 83, and 110%, respectively, for Run 710-2A). The mist eliminator was 18% restricted.	SO_2 removal averaged 69% vs 64% for Run 711-2A. Limestone utilization was 83% and gypsum saturation 60% (cf. 80 and 80%, respectively, for Run 711-2A). Mist eliminator restriction was 20%.	

Table H-5

SUMMARY OF AUTOMATIC LIMESTONE FEED CONTROL TESTS ON THE TCA SYSTEM

Run Number	713-2A	714-2A
Start-of-Run Date	6/15/77	8/30/77
End-of-Run Date	6/24/77	9/07/77
On Stream Hours	202	201
Fly Ash	Yes	Yes
MgO Addition	No	No
Gas Rate, acfm @ 300°F	30,000	30,000
Gas Velocity, fps @ 125°F	12.5	12.5
Liquor Rate, gpm	1200	1200
L/G, gal/Mcf	50	50
Percent Solids Recirculated	14.1 - 15.7	14.1 - 16.3
Effluent Residence Time, min	12	4.1
Stoichiometric Ratio, moles Ca added/mole SO_2 absorbed	1.20 - 1.36	1.18 - 1.55
Avg. % Limestone Utilization, 100x moles SO_2abs./mole Ca added	78	73
Inlet O_2 Concentration, vol. %	7.0 - 8.9	6.0 - 8.9
Inlet SO_2 Concentration, ppm	2200 - 3100	2100 - 3400
Percent SO_2 Removal	76 - 88	80 - 93
Avg. SO_2 Make-Per-Pass, mmole/l	11.5	12.4
Scrubber Inlet pH Range	5.5 - 5.9	5.5 - 6.0
Scrubber Outlet pH Range	5.2 - 5.4	5.1 - 5.7
Percent Sulfite Oxidized	13 - 23	2 - 31
Solids Disposal System	Clarifier	Clarifier
Solids in Sludge Discharged, %	38 - 42	32 - 40
Calculated Avg. % Gypsum Saturation in Scrubber Inlet Liquor @ 50°C	95	75
Total Dissolved Solids, ppm	4000 - 5400	4100 - 6700
Total ΔP Range Excluding Mist Elimination System, in. H_2O	7.0 - 9.4	7.7 - 9.0
Mist Elimination System ΔP Range, in. H_2O	0.44 - 0.50	0.33 - 0.46
Mist Elimination System Configuration	3-pass, open-vane, 316L SS chevron mist eliminator.	3-pass, open-vane, 316L SS chevron mist eliminator.
Absorbent	Limestone slurried to 60 wt% with makeup water and added to EHT by automatic control.	Limestone slurried to 60 wt% with makeup water and added to EHT by automatic control.
Mist Eliminator Washing Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.55 gpm/sq. ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all makeup water plus necessary clarified liquor) at 0.4 gpm/sq. ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.55 gpm/sq. ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all makeup water plus necessary clarified liquor) at 0.4 gpm/sq. ft.
Scrubber Internals	Three beds (4 grids) with 5 in./bed of nitrile foam spheres. New spheres in middle bed.	Three beds (4 grids) with nominally 5 in./bed of nitrile foam spheres from TCA Run 810-2A.
System Changes Before Start of Run	No cleaning after pressure drop tests with air and water during April-June 1977 boiler outage. Installed automatic limestone feed control system.	Fan damper cleaned. No other changes.
Method of Control	Automatic limestone feed control at a stoichiometric ratio of 1.35 moles Ca/mole SO_2 absorbed and at a desired outlet SO_2 concentration of 430 ppm.	Automatic limestone feed control at a stoichiometric ratio of 1.35 moles Ca/mole SO_2 absorbed and at a desired outlet SO_2 concentration of 430 ppm.
Run Philosophy	First of a series of automatic limestone feed control tests on the TCA. Control equation: limestone addition rate = G x (SO_2 in - desired SO_2 out) x desired stoich. ratio x constant. Constant gas rate, no overrides.	Test of the automatic limestone feed control on the TCA. Control equation: limestone addition rate = G x (SO_2 in - desired SO_2 out) x desired stoich. ratio x constant. Constant gas rate.
Results	Problems with the control instrumentation during the first run caused this series of tests to be postponed.	Automatic limestone feed control system functioned according to design specifications. Actual limestone stoichiometric ratio varied between 1.18 and 1.55 with generally increasing trend during the run. SO_2 removal averaged 87%. The mist eliminator was entirely clean.

Table H-6

SUMMARY OF LIMESTONE TESTS WITH HIGH FLY ASH LOADING ON THE TCA SYSTEM

Run Number	715-2A	716-2A	717-2A	
Start-of-Run Date	10/ 7/77	10/14/77	10/20/77	
End-of-Run Date	10/14/77	10/20/77	11/21/77	
On Stream Hours	161	135	747	
Fly Ash	Yes	Yes	Yes	
MgO Addition	No	No	No	
Gas Rate, acfm @ 100°F	30,000	27,000	20,000 - 30,000	
Gas Velocity, fps @ 125°F	12.5	11.5	8.4 - 12.5	
Liquor Rate, gpm	1000	1000	1000	
L/G, gal/Mcf	42	46	42 - 62	
Percent Solids Recirculated	14.6 - 15.6	13.8 - 15.1	13.7 - 15.7	
Effluent Residence Time, min.	14.4 (3 tanks)	14.4 (3 tanks)	14.4 (3 tanks)	
Stoichiometric Ratio, moles Ca added/mole SO_2 absorbed	1.16 - 1.30	1.09 - 1.24	1.10 - 1.38	
Avg. % Limestone Utilization, 100x moles SO_2 abs./mole Ca added	81	86	81	
Inlet O_2 Concentration, vol. %	7.6 - 9.4	6.3 - 8.9	5.8 - 8.2	
Inlet SO_2 Concentration, ppm	2500 - 3500	2300 - 3100	2200 - 3400	
Percent SO_2 Removal	82 - 90	86 - 96	80 - 94	
Avg. SO_2 Make-Per-Pass, m-mole/l	15.8	14.0	6.9 - 18.8	
Scrubber Inlet pH Range	5.65 - 5.85	5.6 - 5.95	5.7 - 6.1	
Scrubber Outlet pH Range	5.0 - 5.4	5.0 - 5.5	5.1 - 5.7	
Percent Sulfite Oxidized	14 - 28	16 - 34	12 - 32	
Solids Disposal System	Clarifier	Clarifier	Clarifier	
Solids in Sludge Discharged, %	30 - 42	33 - 41	31 - 46	
Calculated Avg. % Gypsum Saturation in Scrubber Inlet Liquor @ 50°C	100	101	90	
Total Dissolved Solids, ppm	5200 - 7100	5500 - 6800	4400 - 7000	
Total ΔP Range Excluding Mist Elimination System, in. H_2O	10.0 - 12.5	12.8 - 16.1	5.8 - 13.6	
Mist Elimination System ΔP Range, in. H_2O	0.44 - 0.55	0.34 - 0.44	0.17 - 0.42	
Mist Elimination System Configuration	3-pass, open-vane, 316L SS chevron mist eliminator.	3-pass, open-vane, 316L SS chevron mist eliminator.	3-pass, open-vane, 316L SS chevron mist eliminator.	
Absorbent	Limestone slurried to 60 wt% with makeup water and added to first hold tank.	Limestone slurried to 60 wt% with makeup water and added to first hold tank.	Limestone slurried to 60 wt% with makeup water and added to first hold tank.	
Mist Eliminator Washing Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.55 gpm/sq. ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) at 0.4 gpm/sq. ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.55 gpm/sq. ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) at 0.4 gpm/sq. ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.55 gpm/sq. ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) at 0.3 gpm/sq. ft.	
Scrubber Internals	Three beds (4 grids) with nominally 7.5 inches/bed of nitrile foam spheres from Run 814-2A plus additional spheres.	Three beds (4 grids) with nominally 10 inches/bed of nitrile foam spheres from Run 715-2A plus additional spheres.	Three beds (4 grids) with nominally 7.5 inches/bed of nitrile foam spheres from Run 716-2A (22.5 inches actual total bed height).	
System Changes Before Start of Run	A 16-inch diameter pipe connection between the first and second hold tank was modified to allow overflow from first hold tank to enter bottom of second hold tank. Nitrile foam spheres added to increase bed height from 5 to 7 inches per bed. No cleaning.	Nitrile foam spheres added to beds for nominally 30 inch total bed height. No cleaning.	Cleaned the fan damper, outlet duct from the scrubber to reheater, bottom bar grid, and scrubber walls below the bottom grid. Total static bed height reduced from 30 to 22.5 inches.	
Method of Control	TCA inlet pH controlled at 5.75 ± 0.2. Clarified liquor (excess of mist eliminator wash) returned to first hold tank.	TCA inlet pH controlled at 5.75 ± 0.2. Clarified liquor (excess of mist eliminator wash) returned to first hold tank.	Limestone stoichiometric ratio controlled at 1.2 moles Ca/mole SO_2 absorbed by automatic feed system.	
Run Philosophy	To achieve 84% SO_2 removal at 2800 ppm average inlet SO_2 concentration (to meet EPA SO_2 emission standard). Also, to meet EPA particulate emission standard (0.052 gr/dry scf at 10% excess air).	To see whether an outlet mass loading of 0.02 gr/dry scf, or less, could be achieved at 30 inches total bed height.	This was a one-month reliability test. Test conditions were selected to meet EPA emission standards (1.2 lbs SO_2 and 0.1 lb particulate per 10^6 Btu) and to give reliable scrubber and mist eliminator operation.	
Results	SO_2 removal averaged 86% at 3000 ppm average inlet SO_2 concentration. Limestone utilization was 81%. Average outlet particulate mass loading was 0.039 gr/dry scf. The mist eliminator was entirely clean at the end of the run.	SO_2 removal averaged 91% at 2700 ppm average inlet SO_2 concentration. Limestone utilization was 86%. Average outlet particulate mass loading was 0.025 gr/dry scf. The mist eliminator was entirely clean at the end of the run.	For the entire run, SO_2 removal averaged 87% at 2800 ppm inlet SO_2, which was higher than the 83% removal required to meet the emission standard. However, the standard was frequently exceeded for periods greater than the 3 hours allowed by EPA regulations. Average outlet mass loading was 0.061 gr/scf dry (0.026 - 0.069 range) which was better than the 0.052 gr/scf dry (at 10% excess air) required to meet the standard. Mist eliminator was 1% restricted at the end of the run. No significant increase in solids deposits below the bottom grid.	

Table H-7

SUMMARY OF CEILCOTE SUPPORT PLATE PACKING TESTS ON THE TCA SYSTEM

Run Number	718-2A	719-2A	
Start-of-Run Date	11/24/77	12/1/77	
End-of-Run Date	11/30/77	12/9/77	
On Stream Hours	143	183	
Fly Ash	Yes	Yes	
MgO Addition	No	No	
Gas Rate, acfm @ 300°F	30,000	18,000	
Gas Velocity, fps @ 125°F	12.5	7.5	
Liquor Rate, gpm	1200	1200	
L/G, gal/Mcf	55	81	
Percent Solids Recirculated	13.6 - 15.1	14.1 - 15.5	
Effluent Residence Time, min.	12	12	
Stoichiometric Ratio, moles Ca added/mole SO_2 absorbed	1.17 - 1.48	1.08 - 1.24	
Avg. % Limestone Utilization, 100x moles SO_2 abs./mole Ca added	75	86	
Inlet O_2 Concentration, vol. %	5.9 - 9.8	6.1 - 10.0	
Inlet SO_2 Concentration, ppm	2800 - 3600	2700 - 3400	
Percent SO_2 Removal	73 - 79	84 - 88	
SO_2 Make-Per-Pass, m-mole/l	13.5	8.4	
Scrubber Inlet pH Range	5.6 - 5.9	5.6 - 5.9	
Scrubber Outlet pH Range	—	5.0 - 5.4	
Percent Sulfite Oxidized	14 - 28	13 - 25	
Solids Disposal System	Clarifier	Clarifier	
Solids in Sludge Discharged, %	36 - 40	35 - 41	
Calculated Avg. % Gypsum Saturation in Scrubber Inlet Liquor @ 50°C	110	108	
Total Dissolved Solids, ppm	6000 - 7500	5100 - 5700	
Total ΔP Range Excluding Mist Elimination System, in. H_2O	6.5 - 8.2	2.6 - 4.0	
Mist Elimination System ΔP Range, in. H_2O	0.40 - 0.52	0.11 - 0.20	
Mist Elimination System Configuration	3-pass, open-vane, 316L SS chevron mist eliminator.	3-pass, open-vane, 316L SS chevron mist eliminator.	
Absorbent	Limestone slurried to 60 wt% with makeup water and added to effluent hold tank.	Limestone slurried to 60 wt% with makeup water and added to effluent hold tank.	
Mist Eliminator Washing Scheme	Top washed sequentially with makeup water. Each nozzle (5 total) on 1 min. (at 0.55 gpm/sq. ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) at 0.4 gpm/sq. ft.	Top washed sequentially with makeup water. Each nozzle (5 total) on 1 min. (at 0.55 gpm/sq. ft.) with 7 min. off between nozzles. Bottom washed intermittently with makeup water through 2 nozzles at 1.5 gpm/sq. ft. for 4 min. every hour.	
Scrubber Internals	Four grids with 23 layers (46 inches total height) of egg-crate type Ceilcote plates between 2nd and 3rd grids.	Four grids with 23 layers (46 inches total height) of egg-crate type Ceilcote plates between 2nd and 3rd grids.	
System Changes Before Start of Run	All nitrile foam spheres removed and Ceilcote plates installed. No cleaning.	No changes. No cleaning.	
Method of Control	Limestone stoichiometric ratio controlled at 1.2 moles Ca/mole SO_2 absorbed by automatic feed system.	Limestone stoichiometric ratio controlled at 1.2 moles Ca/mole SO_2 absorbed by automatic feed system.	
Run Philosophy	To compare the SO_2 removal efficiency of Ceilcote packing with that of the nitrile foam spheres.	To compare the turn-down capability (to 1800 acfm gas rate) of the Ceilcote plate packing with that of the nitrile foam spheres.	
Results	SO_2 removal averaged 76% at 3200 ppm inlet SO_2 and 7.2 in. H_2O pressure drop across the Ceilcote plates (including 4 grids). The SO_2 removal was somewhat lower than that with 15 inches total static height of spheres (including 4 grids) which normally gave about 8 in. H_2O pressure drop under the same gas and liquor rates. Mist eliminator was 0.6% restricted. Very minor scale deposit on upper layers of Ceilcote plates. Average outlet mass loading was 0.042 gr/scf dry (0.038 - 0.046 range).	SO_2 removal averaged 86% at 3050 ppm inlet SO_2 and 3.0 in. H_2O pressure drop across the Ceilcote plates (including 4 grids). The SO_2 removal was somewhat higher than that of a 3-bed 4-grid TCA with 5 inches of spheres per bed under the same operating conditions. The mist eliminator was 0.5% restricted. Minor scale deposits on some sections of plate packing were found. Average outlet mass loading was 0.057 gr/scf dry (0.050-0.065 range).	

Table H-8

SUMMARY OF FORCED-OXIDATION LIMESTONE TESTS WITH AIR EDUCTOR ON THE TCA SYSTEM

Run Number	801-2A/801-2B	802-2A	803-2A	804-2A
Start-of-Run Date	6/24/77	7/1/77	7/8/77	7/15/77
End-of-Run Date	6/30/77	7/7/77	7/15/77	7/22/77
On Stream Hours	102/47	142	169	[illegible]
Fly Ash	Yes	Yes	Yes	Yes
MgO Addition	No	No	No	No
Gas Rate, acfm @ 100°F	30,000	30,000	30,000	30,000
Gas Velocity, fps @ 125°F	12.5	12.5	12.5	12.5
Liquor Rate, gpm	1200	1200	1200	1200
L/G, gal/Mcf	50	40	40	50
Percent Solids Recirculated	11.8 - 15.4	14.7 - 15.9	14.1 - 16.7	14.5 - 16.3
Effluent Residence Time, min	12/15.7	23.5	23.5	23.5
Effluent Tank Level, ft	6.1/8.0	12	12	12
Low pH Tank Residence Time, min	--	--	--	--
Stoichiometric Ratio, moles Ca added/mole SO_2 absorbed	1.10 - 1.40	1.14 - 1.29	1.02 - 1.25	1.04 - 1.11
Avg. % Limestone Utilization, 100x moles SO_2 abs./mole Ca added	85	82	90	93
Inlet O_2 Concentration, vol. %	9.1 - 9.8	7.5 - 8.5	7.6 - 9.4	6.8 - 7.8
Inlet SO_2 Concentration, ppm	1900 - 3600	2700 - 3150	2800 - 3100	2950 - 3400
Percent SO_2 Removal	64 - 75	72 - 80	54 - 70	54 - 65
Average SO_2 Make-per-pass, mmole/l	10.3	11.8	9.3	15.4
Scrubber Inlet pH Range	5.65 - 6.0	5.6 - 5.9	4.9 - 5.5	4.8 - 5.2
Scrubber Outlet pH Range	5.0 - 5.3	5.0 - 5.1	3.7 - 4.2	3.4 - 4.3
Solids Disposal System	Clarifier	Clarifier	Clarifier	Clarifier
Solids in Sludge Discharged, %	34 - 45	32 - 38	33 - 48	50 - 59
Calculated Avg. % Gypsum Saturation in Scrubber Inlet Liquor @ 50°C	105	100	135	139
Total Dissolved Solids, ppm	4500 - 5100	4800 - 5200	5400 - 6400	6100 - 7600
Total ΔP Range Excluding Mist Elimination System, in. H_2O	6.7 - 7.5	7.9 - 9.0	7.9 - 8.3	7.6 - 8.4
Mist Elimination System ΔP Range, in. H_2O	0.47 - 0.51	0.47 - 0.54	0.40 - 0.52	0.40 - 0.48
Mist Elimination System Configuration	3-pass, open-vane, 316L SS chevron mist eliminator.	3-pass, open-vane, 316L SS chevron mist eliminator.	3-pass, open-vane, 316L SS chevron mist eliminator.	3-pass, open-vane, 316L SS chevron mist eliminator.
Mist Eliminator Washing Scheme	Top washed sequentially with makeup water. Each nozzle (1 total) on 3 minutes (at 0.55 gpm/sq. ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all makeup water plus necessary clarified liquor) at 0.4 gpm/sq. ft.	Top washed sequentially with makeup water. Each nozzle (1 total) on 3 minutes (at 0.55 gpm/sq. ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all makeup water plus necessary clarified liquor) at 0.4 gpm/sq. ft.	Top washed sequentially with makeup water. Each nozzle (1 total) on 3 min. (at 0.55 gpm/sq. ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all makeup water plus necessary clarified liquor) at 0.4 gpm/sq. ft.	Top washed sequentially with makeup water. Each nozzle (1 total) on 3 min. (at 0.55 gpm/sq. ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all makeup water plus necessary clarified liquor) at 0.4 gpm/sq. ft.
Percent Sulfite Oxidation	40-55/53-72	43 - 59	84 - 97	86 - 100
Oxidizer (Air Eductor) Inlet pH Range	5.64 - 6.0	5.5 - 5.9	4.9 - 5.3	4.8 - 5.2
Air Flow Rate to Oxidizer, acfm	600 (Est.)/530	485	475	410
Liquor Flow Rate to Oxidizer, gpm	1590	1650	1600	1600
Avg. Air Stoichiometric Ratio, lb-atoms oxygen/lb-mole SO_2 absorbed	5.4/5.6	4.5	5.3	4.5

Table H-8 (continued)

SUMMARY OF FORCED-OXIDATION LIMESTONE TESTS WITH AIR EDUCTOR ON THE TCA SYSTEM

Run Number	801-2A/801-2B	802-2A	803-2A	804-2A
Oxidation Configuration	Single tank configuration with separate slurry recirculation loops to TCA and air eductor (Penberthy ELL-10 Special). Air eductor mounted vertically and off-centered in effluent hold tank. Four ft section of 10 inch diameter pipe attached beneath the discharge nozzle of eductor. Pipe discharged 6 ft from bottom of tank. (Tank slurry level at 6 ft 2 in. for Run 801-2A and at 8 ft for Run 801-2B.)	Single tank configuration with separate slurry recirculation loops to TCA and air eductor (Penberthy ELL-10 Special). Air eductor mounted vertically and off-centered in effluent hold tank. The 4 ft section of pipe attached beneath the discharge nozzle of eductor was removed before this run. Eductor discharged 10 ft from bottom of tank. (Tank slurry level at 12 ft.)	Single tank configuration with separate slurry recirculation loops to TCA and air eductor (Penberthy ELL-10 Special). Air eductor mounted vertically and off-centered in effluent hold tank. Eductor discharged 10 ft. from bottom of tank. (Tank slurry level at 12 ft.)	Single tank configuration with separate slurry recirculation loops to TCA and air eductor (Penberthy ELL-10 Special). Air eductor mounted vertically and off-centered in effluent hold tank. Eductor discharged 10 ft from bottom of tank. (Tank slurry level at 12 ft.) Effluent hold tank agitator speed increased from 45 to 68 rpm.
Absorbent	Limestone slurried to 10 wt% with makeup water and added to effluent hold tank.	Limestone slurried to 10 wt% with makeup water and added to effluent hold tank.	Limestone slurried to 10 wt% with makeup water and added to effluent hold tank.	Limestone slurried to 10 wt% with makeup water and added to effluent hold tank.
Scrubber Internals	Three beds (4 grids) with 5 inches/bed of nitrile foam spheres from TCA Run 711-2A.	Three beds (4 grids) with 5 inches/bed of nitrile foam spheres from TCA Run 801-2B.	Three beds (4 grids) with nominally 5 inches/bed of nitrile foam spheres from TCA Run 802-2A (14 inches actual).	Three beds (4 grids) with nominally 5 inches/bed of nitrile foam spheres from TCA Run 803-2A (14 inches actual).
System Changes Before Start of Run	No cleaning. System modified for forced oxidation with either one or two tank operation. Installed air eductor.	No inspection. No cleaning. Removed 4 ft section of 10 inch diameter pipe attached beneath the discharge nozzle of eductor.	No changes. No cleaning.	(No shutdown.) Effluent hold tank agitator speed increased from 45 to 68 rpm.
Method of Control	Limestone stoichiometric ratio controlled at 1.2 moles Ca/mole SO_2 absorbed. Slurry flow rate to air eductor controlled at 1600 gpm.	Limestone stoichiometric ratio controlled at 1.2 moles Ca/mole SO_2 absorbed. Slurry flow rate to air eductor controlled at 1600 gpm.	TCA inlet pH controlled at 5.0 ± 0.2. Slurry flow rate to air eductor controlled at 1600 gpm.	TCA inlet pH controlled at 5.0 ± 0.2. Slurry flow rate to air eductor controlled at 1600 gpm.
Run Philosophy	First forced oxidation tests with an air eductor and with limestone scrubbing on the TCA. One tank oxidation scheme.	To test whether increased hold tank slurry volume will increase sulfite oxidation.	To test whether lower pH will increase sulfite oxidation.	To test whether increased agitator speed in the effluent hold tank would increase air/slurry contact and thus increase sulfite oxidation.
Results	Sulfite oxidation averaged only 53% during Run 801-2A. Raising the tank level two feet during Run 801-2B to ensure a liquid seal on the eductor improved sulfite oxidation only 10% (to 63%). Overall SO_2 removal averaged 70% and limestone utilization averaged 80%. No inspection was made at the end of the runs.	Sulfite oxidation averaged only 56%. SO_2 removal averaged 76% and limestone utilization averaged 82%. The mist eliminator was entirely clean at the end of the run.	Sulfite oxidation increased to 91% but SO_2 removal dropped to 62%. Limestone utilization averaged 95%. Scrubber was not shut down at the end of the run.	Sulfite oxidation averaged 91%. SO_2 removal averaged 62%. Limestone utilization averaged 91%. The mist eliminator was entirely clean at the end of the run.

Table H-8 (continued)

SUMMARY OF FORCED-OXIDATION LIMESTONE TESTS WITH AIR EDUCTOR ON THE TCA SYSTEM

Run Number	805-2A	806-2A	807-2A	808-2A
Start-of-Run Date	7/22/77	7/28/77	8/ 2/77	8/10/77
End-of-Run Date	7/28/77	8/2/77	8/10/77	8/17/77
On Stream Hours	140	115	185	162
Fly Ash	Yes	Yes	Yes	Yes
MgO Addition	No	No	No	No
Gas Rate, acfm @ 300°F	30,000	30,000	30,000	30,000
Gas Velocity, fps @ 125°F	12.5	12.5	12.5	12.5
Liquor Rate, gpm	1200	1200	1200	1200
L/G, gal/Mcf	50	50	50	50
Percent Solids Recirculated	14.0 - 16.0	13.9 - 15.0	13.8 - 16.0	13.7 - 15.9
Effluent Residence Time, min	23.5	23.5	23.5	23.5
Effluent Tank Level, ft	12	12	12	12
Low pH Tank Residence Time, min.	--	--	2.9	2.9
Stoichiometric Ratio, moles Ca added/mole SO_2 absorbed	1.04 - 1.33	1.01 - 1.17	1.1 - 1.35	1.43 - 1.72
Avg. % Limestone Utilization, 100x moles SO_2 abs./mole Ca added	84	91	82	63
Inlet O_2 Concentration, vol. %	6.8 - 8.5	7.5 - 9.2	6.8 - 8.4	7.2 - 10.2
Inlet SO_2 Concentration, ppm	2700 - 3400	2600 - 3400	2000 - 3400	2500 - 3300
Percent SO_2 Removal	64 - 79	66 - 73	74 - 92	62 - 80
Average SO_2 Make-Per-Pass, mmole/l	11.7	10.9	11.8	10.6
Scrubber Inlet pH Range	5.1 - 5.55	5.2 - 5.5	5.3 - 5.6	4.95 - 5.25
Scrubber Outlet pH Range	4.1 - 4.7	4.7 - 4.9	4.6 - 5.0	4.5 - 4.9
Solids Disposal System	Clarifier	Clarifier	Clarifier	Clarifier
Solids in Sludge Discharged, %	26 - 39	32 - 44	28 - 44	24 - 54
Calculated Avg. % Gypsum Saturation in Scrubber Inlet Liquor @ 50°C	105	110	100	125
Total Dissolved Solids, ppm	5400 - 6500	5700 - 7400	5600 - 6800	7700 - 8700
Total ΔP Range Excluding Mist Elimination System, in. H_2O	7.7 - 8.7	7.9 - 9.4	8.2 - 8.8	8.0 - 8.5
Mist Elimination System ΔP Range, in. H_2O	0.37 - 0.46	0.31 - 0.40	0.34 - 0.44	0.44 - 0.50
Mist Elimination System Configuration	3-pass, open-vane, 316L SS chevron mist eliminator.	3-pass, open-vane, 316L SS chevron mist eliminator.	3-pass, open-vane, 316L SS chevron mist eliminator.	3-pass, open-vane, 316L SS chevron mist eliminator.
Mist Eliminator Washing Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.55 gpm/sq. ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all makeup water plus necessary clarified liquor) at 0.4 gpm/sq. ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.55 gpm/sq. ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all makeup water plus necessary clarified liquor) at 0.4 gpm/sq. ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.55 gpm/sq. ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all makeup water plus necessary clarified liquor) at 0.4 gpm/sq. ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.55 gpm/sq. ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all makeup water plus necessary clarified liquor) at 0.4 gpm/sq. ft.
Percent Sulfite Oxidation	88 - 98	37 - 79	93 - 99	86 - 99
Oxidizer (Air Eductor) Inlet pH Range	5.0 - 5.5	5.2 - 5.4	5.0 - 5.2	4.85 - 5.05
Air Flow Rate to Oxidizer, scfm	470	290	475	200
Liquor Flow Rate to Oxidizer, gpm	1600	1200	1600	1600
Avg. Air Stoichiometric Ratio, lb-atoms oxygen/lb-mole SO_2 absorbed	4.4	2.8	4.1	2.0

Table H-8 (continued)

SUMMARY OF FORCED-OXIDATION LIMESTONE TESTS WITH AIR EDUCTOR ON THE TCA SYSTEM

Run Number	805-2A	806-2A	807-2A	808-2A
Oxidation Configuration	Single tank configuration with separate slurry recirculation loops to TCA and air eductor (Penberthy ELL-10 Special). Air eductor mounted vertically and off centered in effluent hold tank. Eductor discharged 10 ft from bottom of tank. (Tank slurry level at 12 ft.) Effluent hold tank agitator speed at 68 rpm.	Single tank configuration with separate slurry recirculation loops to TCA and air eductor (Penberthy ELL-10 Special). Air eductor mounted vertically and off centered in effluent hold tank. Eductor discharged 10 ft from bottom of tank. (Tank slurry level at 12 ft.) Effluent hold tank agitator speed at 68 rpm.	Two tank configuration with slurry flow from TCA to low pH tank to air eductor (Penberthy ELL-10 Special) to EHT and back to TCA. Air eductor mounted vertically and off centered in EHT. Eductor discharged 10 ft from bottom of tank. (Tanks slurry level at 12 ft.) EHT agitator speed at 68 rpm.	Two tank configuration with slurry flow from TCA to low pH tank to air eductor (Penberthy ELL-10 Special) to EHT and back to TCA. Air eductor mounted vertically and off centered in EHT. Eductor discharged 10 ft from bottom of tank. (Tank slurry level at 12 ft.) EHT agitator speed at 68 rpm. Air flow to eductor controlled by sliding plate in air intake line.
Absorbent	Limestone slurried to 60 wt% with makeup water and added to 1200 gpm TCA inlet stream.	Limestone slurried to 60 wt% with makeup water and added to the 1200 gpm TCA inlet stream.	Limestone slurried to 60 wt. % with makeup water and added to effluent hold tank.	Limestone slurried to 60 wt. % with makeup water and added to effluent hold tank.
Scrubber Internals	Three beds (4 grids) with nominally 5 inches/bed of nitrile foam spheres from TCA Run 804-2A (14 inches actual).	Three beds (4 grids) with nominally 5 inches/bed of nitrile foam spheres from TCA Run 805-2A (14 inches actual).	Three beds (4 grids) with nominally 5 inches/bed of nitrile foam spheres from TCA Run 806-2A (14 inches actual).	Three beds (4 grids) with nominally 5 inches/bed of nitrile foam spheres from TCA Run 807-2A.
System Changes Before Start of Run	No cleaning. Limestone addition point moved to TCA inlet line.	No cleaning. No changes.	Installation of external downcomer to low pH tank and conversion to two tank configuration. No. cleaning.	Installation of sliding plate in air intake line to air eductor. No cleaning.
Method of Control	TCA inlet pH controlled at 5.3 ± 0.2. Slurry flow rate to air eductor controlled at 1600 gpm.	TCA inlet pH controlled at 5.3 ± 0.2. Slurry flow rate to air eductor controlled at 1200 gpm.	TCA inlet pH controlled at 5.4 ± 0.2. Slurry flow rate to air eductor controlled at 1600 gpm.	Limestone stoichiometric ratio controlled at 1.3. Slurry flow rate to air eductor controlled at 1600 gpm. Air flow rate to eductor controlled at 200 scfm.
Run Philosophy	To test the effects of limestone addition to the TCA inlet line. Good oxidation should still be achieved by maintaining low pH in the EHT. SO_2 removal should increase by increasing the TCA inlet pH.	To test whether good oxidation can be achieved at a lower eductor liquor feed rate of 1200 gpm (and a corresponding lower air rate).	First single-stage forced oxidation test using two tanks, including a low pH tank to feed low pH slurry to air eductor for better sulfite oxidation.	To observe the effect of decreased air stoichiometry (2.9 compared with 4.1 for Run 807-2A) on sulfite oxidation.
Results	SO_2 removal increased from 62 to 72%. Sulfite oxidation remained high at 93%. Limestone utilization averaged 84%. The mist eliminator was entirely clean at the end of the run.	Sulfite oxidation averaged only 58%. SO_2 removal averaged 70%. Limestone utilization averaged 91%. The mist eliminator was entirely clean at the end of the run.	Sulfite oxidation improved and averaged 96%. SO_2 removal averaged 83%. Limestone utilization averaged 82%. The mist eliminator was entirely clean.	Sulfite oxidation remained high at 93%. SO_2 removal averaged 71% (at a scrubber inlet pH of 5.1). Limestone utilization averaged only 63% (possibly in error due to analytical problems). The mist eliminator was entirely clean.

Table H-8 (continued)

SUMMARY OF FORCED-OXIDATION LIMESTONE TESTS WITH AIR EDUCTOR ON THE TCA SYSTEM

Run Number	809-2A	810-2A	811-2A	812-2A
Start-of-Run Date	8/17/77	8/24/77	9/09/77	9/16/77
End-of-Run Date	8/23/77	8/29/77	9/16/77	9/22/77
On Stream Hours	149	130	164	141
Fly Ash	Yes	Yes	Yes	Yes
MgO Addition	No	No	No	No
Gas Rate, acfm @ 300°F	30,000	30,000	30,000	30,000
Gas Velocity, fps @ 125°F	12.5	12.5	12.5	12.5
Liquor Rate, gpm	1200	1200	1200	1200
L/G, gal/Mcf	50	50	50	50
Percent Solids Recirculated	14.1 - 17.1	14.0 - 15.9	13.5 - 15.7	13.8 - 16.1
Effluent Residence Time, min	15.7	15.7	23.5	15.7
Effluent Tank Level, ft	8	8	12	8
Low pH Tank Residence Time, min	1.9	1.9	2.9	1.9
Stoichiometric Ratio, moles Ca added/mole SO_2 absorbed	1.52 - 1.68	1.1 - 1.5	1.5 - 1.85	1.43 - 2.11
Avg. % Limestone Utilization, 100x moles SO_2 abs./mole Ca added	63	77	60	56
Inlet O_2 Concentration, vol. %	5.5 - 7.5	6.5 - 10.0	6.0 - 8.0	7.6 - 8.7
Inlet SO_2 Concentration, ppm	2600 - 3800	2600 - 3200	2300 - 3300	2400 - 3600
Percent SO_2 Removal	68 - 85	78 - 89	83 - 91	75 - 87
Average SO_2 Make-Per-Pass, m-mole/l	13.2	12.8	12.4	12.8
Scrubber Inlet pH Range	5.0 - 5.4	5.35 - 5.65	5.6 - 6.1	5.3 - 5.7
Scrubber Outlet pH Range	4.55 - 4.9	4.65 - 5.05	5.0 - 5.3	4.9 - 5.2
Solids Disposal System	Clarifier & Filter	Clarifier & Filter	Clarifier	Clarifier
Solids in Sludge Discharged, %	80 - 89	84 - 91	35 - 50	32 - 44
Calculated Avg. % Gypsum Saturation in Scrubber Inlet Liquor @ 50°C	115	110	100	100
Total Dissolved Solids, ppm	7200 - 9800	7500 - 8500	4700 - 5400	5100 - 6000
Total ΔP Range Excluding Mist Elimination System, in. H_2O	8.0 - 8.7	8.2 - 9.0	7.6 - 8.6	7.6 - 8.4
Mist Elimination System ΔP Range, in. H_2O	0.35 - 0.43	0.35 - 0.45	0.30 - 0.47	0.30 - 0.50
Mist Elimination System Configuration	3-pass, open-vane, 316L SS chevron mist eliminator.	3-pass, open-vane, 316L SS chevron mist eliminator.	3-pass, open-vane, 316L SS chevron mist elimiantor.	3-pass, open-vane, 316L SS chevron mist eliminator.
Mist Eliminator Washing Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.55 gpm/sq. ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all makeup water plus necessary clarified liquor) at 0.4 gpm/sq. ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.55 gpm/sq. ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarifier liquor (all makeup water plus necessary clarified liquor) at 0.4 gpm/sq. ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.55 gpm/sq. ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarifier liquor (all makeup water plus necessary clarified liquor) at 0.4 gpm/sq. ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.55 gpm/sq. ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarifier liquor (all makeup water plus necessary clarified liquor) at 0.4 gpm/sq. ft.
Percent Sulfite Oxidation	93 - 99	96 - 99	92 - 99	89 - 97
Oxidizer (Air Eductor) Inlet pH Range	4.85 - 5.15	5.0 - 5.25	5.3 - 5.6	5.15 - 5.4
Air Flow Rate to Oxidizer, acfm	300	300	270	350
Liquor Flow Rate to Oxidizer, gpm	1600	1600	1600	1600
Avg. Air Stoichiometric Ratio, lb-atoms oxygen/lb-mole SO_2 absorbed	2.5	2.5	2.3	2.9

Table H-8 (continued)

SUMMARY OF FORCED-OXIDATION LIMESTONE TESTS WITH AIR EDUCTOR ON THE TCA SYSTEM

Run Number	809-2A	810-2A	811-2A	812-2A
Oxidizer Design	Two tank configuration with slurry flow from TCA to low pH tank to air eductor (Penberthy ELL-17 Special) to EHT and back to TCA. Air eductor mounted vertically and off centered in EHT. Four ft section of 12 inch diameter pipe attached beneath discharged nozzle of eductor. Pipe discharged 4 ft from bottom of tank. (Tank slurry level at 8 ft.) EHT agitator speed at 58 rpm. Air flow to eductor controlled by sliding plate in air intake line.	Two tank configuration with slurry flow from TCA to low pH tank to air eductor (Penberthy ELL-17 Special) to EHT and back to TCA. Air eductor mounted vertically and off centered in EHT. Four ft section of 12 inch diameter pipe attached beneath discharged nozzle of eductor. Pipe discharged 4 ft from bottom of tank. (Tank slurry level at 8 ft.) EHT agitator speed at 58 rpm. Air flow to eductor controlled by sliding plate in air intake line.	Two tank configuration with slurry flow from TCA to low pH tank to air eductor (Penberthy ELL-17 Special) to EHT and back to TCA. Air eductor mounted outside of EHT in a horizontal, radial position with centerline 10 in. from bottom of tank. Tank slurry level at 12 ft. EHT agitator speed at 58 rpm.	Two tank configuration with slurry flow from TCA to low pH tank to air eductor (Penberthy ELL-17 Special) to EHT and back to TCA. Air eductor mounted outside of EHT in a horizontal, radial position with centerline 17 in. from bottom of tank. Tank slurry level at 8 ft. EHT agitator speed at 58 rpm.
Absorbent	Limestone slurried to 60 wt.% with makeup water and added to effluent hold tank.	Limestone slurried to 60 wt.% with makeup water and added to effluent hold tank.	Limestone slurried to 60 wt% with makeup water and added to effluent hold tank.	Limestone slurried to 60 wt% with makeup water and added to effluent hold tank.
Scrubber Internals	Three beds (4 grids) with nominally 5 inches/bed of nitrile foam spheres from TCA Run 808-2A.	Three beds (4 grids) with nominally 5 inches/bed of nitrile foam spheres from TCA Run 809-2A.	Three beds (4 grids) with nominally 5 inches/bed of nitrile foam spheres from TCA Run 714-2A.	Three beds (4 grids) with nominally 5 inches/bed of nitrile foam spheres from TCA Run 811-2A. Actual total bed height measured at the end of the run was 12.5 inches.
System Changes Before Start of Run	Addition of 4 ft section of 12 inch diameter pipe beneath the discharge nozzle of eductor. No cleaning.	No changes. No cleaning.	Remounting of air eductor at EHT from vertical, top-entry position to horizontal, bottom-entry position. Sliding plate in eductor air intake line removed (for full air flow). No cleaning.	No changes. No cleaning.
Method of Control	Limestone stoichiometric ratio controlled at 1.3. Slurry flow rate to air eductor controlled at 1400 gpm. Air flow rate to eductor controlled at 300 acfm.	TCA inlet pH controlled at 5.4 ± 0.2. Slurry flow rate to air eductor controlled at 1400 gpm. Air flow rate to eductor controlled at 300 acfm.	Limestone stoichiometric ratio controlled at 1.3. Slurry flow rate to air eductor controlled at 1400 gpm. Full air flow to eductor (270 acfm).	Limestone stoichiometric ratio controlled at 1.3. Slurry flow rate to air eductor controlled at 1400 gpm. Full air flow to eductor (310 acfm).
Run Philosophy	To observe the effect of decreased effluent hold tank slurry level (8 ft compared to 12 ft for Run 808-2A) and the effect of a 300 acfm air flow rate on sulfite oxidation.	To observe the effect of increasing TCA inlet pH on sulfite oxidation and SO_2 removal.	To observe the effect of the horizontal, bottom-entry position of the eductor, as compared to previous vertical, top-entry position (Run 808-2A) on sulfite oxidation.	To observe whether good sulfite oxidation could be achieved with 8 ft. slurry level and to compare with Run 809-2A where the eductor was in the vertical, top-entry position.
Results	Sulfite oxidation remained high at 96%. SO_2 removal averaged 77% at a scrubber inlet pH of 5.2. Limestone utilization averaged only 63% (possibly in error due to analytical problems). The mist eliminator was entirely clean.	Sulfite oxidation was high at 98%. SO_2 removal increased to 84% (compared to 77% for Run 809-2A and 71% for Run 808-2A). Limestone utilization averaged 77%. The mist eliminator was entirely clean.	Sulfite oxidation averaged 96% (compared to 93% in Run 808-2A). SO_2 removal averaged 87%. Limestone utilization averaged 60%. The mist eliminator was 0.2% restricted at the end of the run.	Sulfite oxidation averaged 93% (compared to 96% in Run 809-2A). SO_2 removal averaged 81%. Limestone utilization averaged 56%. The mist eliminator was 0.2% restricted at the end of the run.

Table H-8 (continued)

SUMMARY OF FORCED-OXIDATION LIMESTONE TESTS WITH AIR EDUCTOR ON THE TCA SYSTEM

Run Number	813-2A*	814-2A	
Start-of-Run Date	9/23/77	9/29/77	
End-of-Run Date	9/29/77	10/04/77	
On Stream Hours	130	119	
Fly Ash	Yes	Yes	
MgO Addition	No	No	
Gas Rate, acfm @ 300°F	30,000	30,000	
Gas Velocity, fps @ 125°F	12.5	12.5	
Liquor Rate, gpm	1200	1200	
L/G, gal/Mcf	50	50	
Percent Solids Recirculated	14.5 - 15.5	14.3 - 15.0	
Effluent Residence Time, min	23.5	15.7	
Effluent Tank Level, ft	12	8	
Low pH Tank Residence Time, min			
Stoichiometric Ratio, moles Ca added/mole SO_2 absorbed	1.07 - 1.16	1.06 - 1.28	
Avg. % Limestone Utilization, 100x moles SO_2 abs./mole Ca added	90	85	
Inlet O_2 Concentration, vol. %	7.0 - 8.3	8.5 - 11.0	
Inlet SO_2 Concentration, ppm	2400 - 3500	2100 - 3000	
Percent SO_2 Removal	75 - 85	67 - 81	
Average SO_2 Make-Per-Pass, m-mole/l	11.9	10.1	
Scrubber Inlet pH Range	5.2 - 5.5	5.2 - 5.5	
Scrubber Outlet pH Range	4.5 - 4.7	4.7 - 5.2	
Solids Disposal System	Clarifier	Clarifier	
Solids in Sludge Discharged, %	35 - 44	33 - 42	
Calculated Avg. % Gypsum Saturation in Scrubber Inlet Liquor @ 50°C	90	115	
Total Dissolved Solids, ppm	4600 - 5800	5400 - 6600	
Total Δ P Range Excluding Mist Elimination System, in. H_2O	8.6 - 10.7	6.7 - 10.4	
Mist Elimination System: ΔP Range, in. H_2O	0.47 - 0.58	0.47 - 0.55	
Mist Elimination System Configuration	3-pass, open-vane, 316L SS chevron mist eliminator.	3-pass, open-vane, 316L SS chevron mist eliminator	
Mist Eliminator Washing Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.55 gpm/sq. ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all makeup water plus necessary clarified liquor) at 0.4 gpm/sq. ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.55 gpm/sq. ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all makeup water plus necessary clarified liquor) at 0.4 gpm/sq. ft.	
Percent Sulfite Oxidation	91 - 99	69 - 73	
Oxidizer (Air Eductor) Inlet pH Range	5.05 - 5.25	5.2 - 5.4	
Air Flow Rate to Oxidizer, scfm	115	145	
Liquor Flow Rate to Oxidizer, gpm	1600	1200	
Avg. Air Stoichiometric Ratio, lb-atoms oxygen/lb-mole SO_2 absorbed	2.8	1.6	

Table H-8 (continued)

SUMMARY OF FORCED-OXIDATION LIMESTONE TESTS WITH AIR EDUCTOR ON THE TCA SYSTEM

Run Number	813-2A	814-2A	
Oxidizer Design	Single tank configuration with separate slurry recirculation loops to TCA and air eductor (Penberthy ELL-10 Special). Air eductor mounted outside EHT in a horizontal, radial position with centerline 10 in. from bottom of tank. Tank slurry level at 12 ft. EHT agitator speed at 68 rpm.	Single tank configuration with separate slurry recirculation loops to TCA and air eductor (Penberthy ELL-10 Special). Air eductor mounted outside EHT in a horizontal, radial position with centerline 10 in. from bottom of tank. Tank slurry level at 8 ft. EHT agitator speed at 68 rpm.	
Absorbent	Limestone slurried to 60 wt% with makeup water and added to the 1200 gpm TCA inlet stream.	Limestone slurried to 60 wt% with makeup water and added to the 1200 gpm TCA inlet stream.	
Scrubber Internals	Three beds (4 grids) with nominally 5 inches/bed of nitrile foam spheres from TCA Run 812-2A (15 inches actual total bed height).	Three beds (4 grids) with nominally 5 inches/bed of nitrile foam spheres from TCA Run 813-2A.	
System Changes Before Start of Run	Replaced broken effluent tank agitator shaft. Added nitrile foam spheres to 15 inches total bed height. Limestone addition point moved to TCA inlet line. No cleaning.	No changes. No cleaning.	
Method of Control	TCA inlet pH controlled at 5.5 ± 0.2. Slurry flow rate to air eductor controlled at 1600 gpm. Full air flow to eductor (310 scfm).	TCA inlet pH controlled at 5.5 ± 0.2. Slurry flow rate to air eductor controlled at 1200 gpm. Full air flow to eductor (245 scfm).	
Run Philosophy	To observe the effect on sulfite oxidation of the horizontal, bottom-entry position of the air eductor, as compared to Run 808-2A where the eductor was in the vertical, top-entry position. Both runs were made with single tank configuration.	To observe whether complete sulfite oxidation could be achieved at the reduced 1200 gpm slurry flow rate to the air eductor at 8 ft. tank level.	
Results	Sulfite oxidation averaged 99% (compared to 93% in Run 808-2A). SO_2 removal averaged 80%. Limestone utilization averaged 90%. The mist eliminator was entirely cleaned at the end of the run.	Sulfite oxidation averaged only 91%. SO_2 removal averaged 74%. Limestone utilization averaged 88%. The mist eliminator was entirely clean at the end of the run. The run was terminated after only 119 operating hours because of the problem with erosion of the air eductor.	

Table H-9

SUMMARY OF FORCED-OXIDATION LIMESTONE TESTS WITH AIR SPARGER ON THE TCA SYSTEM

Run Number	815-2A	816-2A	817-2A	818-2A
Start-of-Run Date	12/9/77	12/14/77	12/16/77	12/23/77
End-of-Run Date	12/14/77	12/16/77	12/23/77	12/30/77
On Stream Hours	75	48	161	131
Fly Ash Loading	High	High	High	High
MgO Addition	No	No	No	No
Gas Rate, acfm @ 300°F	30,000	30,000	20,000	25,000
Gas Velocity, fps @ 125°F	12.5	12.5	8.4	10.4
Liquor Rate, gpm	1000	1000	1000	1000
L/G, gal/Mcf	42	42	62	50
Percent Solids Recirculated	14.2 - 15.8	14.7 - 15.7	13.6 - 15.2	14.2 - 15.4
Oxidation Tank Residence Time, min.	6.2	6.2	6.2	6.2
Effluent Hold Tk. Residence Time, min.	14.4	14.4	14.4	14.4
Oxidation Tank Level, ft	18	18	18	18
Stoichiometric Ratio, moles Ca added/mole SO_2 absorbed	1.14 - 1.35	1.26 - 1.39	1.13 - 1.35	1.21 - 1.38
Avg. % Limestone Utilization, 100x moles SO_2 abs./mole Ca added	80	76	81	77
Inlet O_2 Concentration, vol. %	6.5 - 8.5	5.5 - 7.8	6.0 - 8.5	5.6 - 9.4
Inlet SO_2 Concentration, ppm	2500 - 3500	2650 - 3060	2800 - 3200	2800 - 3200
Percent SO_2 Removal	86 - 92	87 - 95	77 - 81	82 - 87
Avg. SO_2 Make-Per-Pass, mmole/l	16.5	16.5	10.8	13.3
Scrubber Inlet pH Range	6.05 - 6.45	6.15 - 6.35	5.65 - 5.95	6.0 - 6.4
Scrubber Outlet pH Range	5.2 - 5.45	5.2 - 5.5	5.0 - 5.4	5.3 - 5.6
Solids Disposal System	Clarifier	Clarifier	Clarifier	Clarifier
Solids in Sludge Discharged, %	35 - 41	30 - 42	31 - 49	36 - 42
Calculated Avg. % Gypsum Saturation in Scrubber Inlet Liquor @ 50°C	110	100	100	98
Total Dissolved Solids, ppm	5200 - 6100	4900 - 5100	4600 - 5400	5000 - 6600
Total ΔP Range Excluding Mist Elimination System, in. H_2O	9.8 - 14.0	10.7 - 15.3	6.5 - 7.2	7.9 - 9.2
Mist Elimination System ΔP Range, in. H_2O	0.44 - 0.54	0.40 - 0.48	0.16 - 0.26	0.26 - 0.36
Mist Elimination System Configuration	3-pass, open-vane, 316 L SS chevron mist eliminator.	3-pass, open-vane, 316 L SS chevron mist eliminator.	3-pass, open-vane, 316L SS chevron mist eliminator.	3-pass, open-vane, 316L SS chevron mist eliminator.
Mist Eliminator Washing Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on for 3 min. (0.55 gpm/sq. ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) at 0.4 gpm/sq. ft. using 2 nozzles.	Top washed sequentially with makeup water. Each nozzle (6 total) on for 3 min. (0.55 gpm/sq. ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) at 0.4 gpm/sq. ft. using 2 nozzles.	Top washed sequentially with makeup water. Each nozzle (6 total) on for 3 min. (0.55 gpm/sq. ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) at 0.3 gpm/sq. ft. using 2 nozzles.	Top washed sequentially with makeup water. Each nozzle (6 total) on for 3 min. (0.55 gpm/sq. ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) at 0.3 gpm/sq. ft. using 2 nozzles.
Percent Sulfite Oxidation	30 - 50	48 - 59	90 - 97	56 - 78
Oxidation tank pH Range	—	5.6 - 5.8	5.2 - 5.7	5.55 - 5.75
Air Flow Rate to Sparger, scfm	130	180/240	130	130
Avg. Air Stoichiometric Ratio, lb-atoms oxygen/lb-mole SO_2 absorbed	1.0	1.40/1.95	1.70	1.25

Table H-9 (continued)

SUMMARY OF FORCED-OXIDATION LIMESTONE TESTS WITH AIR SPARGER ON THE TCA SYSTEM

Run Number	815-2A	816-2A	817-2A	818-2A
Oxidizer Design	Two-tank configuration with slurry flow from TCA to oxidation tank which overflows into EHT and back to TCA. The oxidation tank has an octagonal sparger ring with 40 1/4 inch holes on bottom side. Sparger ring is made of 3 inch 316 L SS piping with 21.5 inch sides and located 8 inches from tank bottom. Oxidation tank agitator speed is 37 rpm with 3 Hp meter. Oxidation tank diameter is 7 ft with 18 ft slurry level.	Two-tank configuration with slurry flow from TCA to oxidation tank which overflows into EHT and back to TCA. The oxidation tank has an octagonal sparger ring with 40 1/4 inch holes on bottom side. Sparger ring is made of 3 inch 316L SS piping with 21.5 inch sides and located 8 inches from tank bottom. Oxidation tank agitator speed is 37 rpm with 3 Hp meter. Oxidation tank diameter is 7 ft with 18 ft slurry level.	Two-tank configuration with slurry flow from TCA to oxidation tank which overflows into EHT and back to TCA. The oxidation tank has an octagonal sparger ring with 40 1/4 inch holes on bottom side. Sparger ring is made of 3 inch 316L SS piping with 21.5 inch sides and located 8 inches from tank bottom. Oxidation tank agitator speed is 37 rpm with 3 Hp meter. Oxidation tank diameter is 7 ft with 18 ft slurry level.	Two-tank configuration with slurry flow from TCA to oxidation tank which overflows into EHT and back to TCA. The oxidation tank has an octagonal sparger ring with 40 1/4 inch holes on bottom side. Sparger ring is made of 3 inch 316L SS piping with 21.5 inch sides and located 8 inches from tank bottom. Oxidation tank agitator speed is 37 rpm with 3 Hp meter. Oxidation tank diameter is 7 ft with 18 ft slurry level.
Absorbent	Limestone slurried to 60 wt% with makeup water and added to the EHT.	Limestone slurried to 60 wt% with makeup water and added to the EHT.	Limestone slurried to 60 wt% with makeup water and added to the EHT.	Limestone slurried to 60 wt% with makeup water and added to the EHT.
Scrubber Internals	Three beds (4 grids) with nominally 5 inches/bed of new and used nitrile foam spheres. Actual total static bed height was 20 inches.	Three beds (4 grids) with nominally 7.5 inches/bed of nitrile foam spheres.	Three beds (4 grids) with nominally 7.5 inches/bed of nitrile foam spheres from Run 816-2A	Three beds (4 grids) with nominally 7.5 inches/bed of nitrile foam spheres from Run 817-2A
System Changes Before Start of Run	Ceilcote plate packing was replaced with nitrile foam spheres. Air sparging system was installed in oxidation tank. No cleaning.	Nitrile foam spheres added for a total static bed height of 22.5 inches. No cleaning.	(No shutdown.)	(No shutdown.)
Method of Control	Limestone stoichiometric ratio controlled at 1.3 moles Ca/mole SO_2 absorbed. Recirculated slurry solids controlled at 15 ± 1%. Clarified liquor returned to EHT.	Limestone stoichiometric ratio controlled at 1.3 moles Ca/mole SO_2 absorbed. Recirculated slurry solids controlled at 15 ± 1%. Clarified liquor returned to EHT.	Limestone stoichiometric ratio controlled at 1.3 moles Ca/mole SO_2 absorbed. Recirculated slurry solids controlled at 15 ± 1%. Clarified liquor returned to EHT.	Limestone stoichiometric ratio controlled at 1.3 moles Ca/mole SO_2 absorbed. Recirculated slurry solids controlled at 15 ± 1%. Clarified liquor returned to EHT.
Run Philosophy	The run was the first TCA forced oxidation test with an air sparger. Test conditions were selected to achieve near complete sulfite oxidation.	Air flow to air sparger was increased to maximum obtainable (180 acfm with V/ST using air and 250 acfm with V/ST shut down) in order to improve sulfite oxidation over Run 815-2A.	Due to lack of sufficient air flow to sparger, the flue gas flow rate was reduced to increase the air stoich. ratio and to improve sulfite oxidation.	Flue gas rate increased while keeping air flow to sparger the same as in Run 817-2A to observe whether good sulfite oxidation could still be achieved at the lower air stoichiometric ratio.
Results	Sulfite oxidation averaged only 40%. SO_2 removal averaged 89% with an average inlet SO_2 concentration of 3000 ppm. Limestone utilization was 80%. The mist eliminator was 0.5% restricted at the end of the run.	Average sulfite oxidation increased to 54% with an average oxidation tank pH of 5.7. SO_2 removal averaged 91% with an inlet SO_2 concentration of 2850 ppm. Limestone utilization was 76%.	Average sulfite oxidation improved to 94% with an average oxidation tank pH of 5.5. SO_2 removal averaged 79% with an inlet SO_2 concentration of 3000 ppm. Limestone utilization was 81%.	Sulfite oxidation averaged 97% with an average oxidation tank pH of 5.65. SO_2 removal was 85% with an inlet SO_2 concentration of 3000 ppm. Limestone utilization was 77%.

Table H-9 (continued)

SUMMARY OF FORCED-OXIDATION LIMESTONE TESTS WITH AIR SPARGER ON THE TCA SYSTEM

Run Number	818-2B	819-2A	820-2A	821-2A
Start-of-Run Date	12/30/77	1/6/78	1/13/78	5/31/78
End-of-Run Date	1/5/78	1/13/78	1/24/78	6/8/78
On Stream Hours	140	164	259	182
Fly Ash Loading	High	High	High	High
MgO Addition	No	No	No	Yes
Gas Rate, acfm @ 300°F	25,000	20,000	20,000	30,000
Gas velocity, fps @ 125°F	10.4	8.4	8.4	12.5
Liquor Rate, gpm	1000	1000	1000	1200
L/G, gal/Mcf	50	62	62	50
Percent Solids Recirculated	13.8 - 14.8	11.3 - 14.5	11.9 - 15.7	13.9 - 15.9
Oxidation Tank Residence Time, min.	5.2	4.9	4.9	4.1
Effluent Hold Tk. Residence Time, min.	14.4	--	--	--
Oxidation Tank Level, ft	18	17	17	17
Stoichiometric Ratio, moles Ca added/mole SO_2 absorbed	1.13 - 1.35	1.13 - 1.48	1.32 - 1.90	1.06 - 1.48[a]
Avg. % Limestone Utilization, 100 x moles SO_2 abs./mole Ca added	81	77	62	79[a]
Inlet O_2 Concentration, vol. %	6.5 - 8.5	7.3 - 11.3	--	6.0 - 8.6
Inlet SO_2 Concentration, ppm	2900 - 3700	2500 - 3100	1700 - 3300	2200 - 2800
Percent SO_2 Removal	78 - 86	66 - 84	66 - 92	74 - 94
Avg. SO_2 Make-Per-Pass, mmole/l	14.5	8.9	8.4	10.5
Scrubber Inlet pH Range	6.05 - 6.35	5.35 - 5.75	5.4 - 5.9	5.1 - 5.6
Scrubber Outlet pH Range	5.2 - 5.6	5.0 - 5.4	5.0 - 5.6	5.0 - 5.3
Solids Disposal System	Clarifier	Clarifier	Clarifier	Clarifier & Centrifuge
Solids in Sludge Discharged, %	35 - 42	32 - 42	32 - 42	78 - 80
Calculated Avg. % Gypsum Saturation in Scrubber Inlet Liquor @ 50°C	110	110	115	110
Total Dissolved Solids, ppm	5300 - 5900	5000 - 6600	5100 - 6800	29,000 - 33,600
Total ΔP Range Excluding Mist Elimination System, in. H_2O	7.8 - 8.5	6.6 - 8.3	6.5 - 7.3	7.1 - 8.6
Mist Elimination System ΔP Range, in. H_2O	0.24 - 0.35	0.11 - 0.26	0.11 - 0.21	0.54 - 0.62
Mist Elimination System Configuration	3-pass, open-vane, 316L SS chevron mist eliminator.	3-pass, open-vane, 316L SS chevron mist eliminator.	3-pass, open-vane, 316L SS chevron mist eliminator.	3-pass, open-vane, 316L SS chevron mist eliminator.
Mist Eliminator Washing Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on for 3 min. (0.55 gpm/sq. ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) at 0.3 gpm/sq. ft. using 2 nozzles.	Top washed sequentially with makeup water. Each nozzle (6 total) on for 3 min. (at 0.55 gpm/sq. ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) at 0.3 gpm/sq. ft. using 2 nozzles.	Top washed sequentially with makeup water. Each nozzle (6 total) on for 3 min. (at 0.55 gpm/sq. ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) at 0.3 gpm/sq. ft. using 2 nozzles.	Top washed sequentially with makeup water. Each nozzle (6 total) on for 3 min. (0.55 gpm/sq. ft.) with 7 min. off between nozzles. Bottom washed intermittently with makeup water. The nozzles (2 total) were on for 4 min. each hour (1.5 gpm/sq. ft.).
Percent Sulfite Oxidized	17 - 31	90 - 98	85 - 98	91 - 99
Oxidation Tank pH Range	--	5.35 - 5.75	5.4 - 5.9	5.1 - 5.6
Air Flow Rate to Sparger, acfm	0	130	130	170
Avg. Air Stoichiometric Ratio, lb atoms oxygen/lb-mole SO_2 absorbed	0	1.90	2.0	1.65 (a) Total stoich. ratio for Ca & Mg is 1.08 - 1.50 (avg. alkali utilization = 78%).

Table H-9 (continued)

SUMMARY OF FORCED-OXIDATION LIMESTONE TESTS WITH AIR SPARGER ON THE TCA SYSTEM

Run Number	818-2B	819-2A	820-2A	821-2A
Oxidizer Design	Two-tank configuration with slurry flow from TCA to oxidation tank which overflows into EHT and back to TCA. The oxidation tk. has an octagonal sparger ring with 40 1/4 inch holes on bottom side. Sparger ring is made of 3 inch 316L SS piping with 21.5 inch sides and located 8 inches from tank bottom. Oxidation tank agitator speed is 37 rpm with 3 Hp motor. Oxidation tank diameter is 7 ft with 18 ft. slurry level.	One tank configuration with slurry flow from TCA to oxidation tank and back to TCA. The oxidation tank has an octagonal sparger ring with 40 1/4 inch holes on bottom side. Sparger ring is made of 3 inch 316L SS piping with 21.5 inch sides and located 8 inches from tank bottom. Oxidation tank agitator speed is 37 rpm with 3Hp motor. Oxidation tank diameter is 7 ft with 17 ft slurry level.	One tank configuration with slurry flow from TCA to oxidation tank and back to TCA. The oxidation tank has an octagonal sparger ring with 40 1/4 inch holes on bottom side. Sparger ring is made of 3 inch 316L SS piping with 21.5 inch sides and located 8 inches from tank bottom. Oxidation tank agitator speed is 37 rpm with 3Hp motor. Oxidation tank diameter is 7 ft with 17 ft slurry level.	One tank configuration with slurry flow from TCA to oxidation tank and back to TCA. The oxidation tank has an octagonal sparger ring with 40 1/4 inch holes on bottom side. Sparger ring is made of 3 inch 316L SS piping with 21.5 inch sides and located 8 inches from tank bottom. Oxidation tank agitation speed is 37 rpm with 3 Hp motor. Oxidation tank diameter is 7 feet. Tank slurry level was 17 ft.
Absorbent	Limestone slurried to 60 wt% with makeup water and added to the EHT.	Limestone slurried to 60 wt% with makeup water and added to oxidation tank.	Limestone slurried to 60 wt% with makeup water and added to oxidation tank.	Limestone slurried to 60 wt% with makeup water and added to oxidation tank. MgO dry fed to oxidation tank.
Scrubber Internals	Three beds (4 grids) with nominally 7.5 inches/bed of nitrile foam spheres from Run 818-1A.	Three beds (4 grids) with nominally 7.5 inches/bed of nitrile foam spheres from Run 818-2B.	Three beds (4 grids) with nominally 7.5 inches/bed of nitrile foam spheres from Run 819-2A.	Three beds (4 grids) with nominally 5 inches/bed of nitrile foam spheres from Run 820-2A.
System Changes Before Start of Run	(No shutdown.)	Changed from two-tank to one-tank configuration (limestone addition and air sparging in the same hold tank). No cleaning.	(No shutdown.)	Cleaned oxidation tank (D-204), cleaned air sparger, and added spheres to increase total static bed height from 19.5 inches to 15 inches. No other changes.
Method of Control	Limestone stoichiometric ratio controlled at 1.3 moles Ca/mole SO_2 absorbed. Recirculated slurry solids controlled at 15 ± 1%. Clarified liquor returned to EHT.	Limestone stoichiometric ratio controlled at 1.3 moles Ca/mole SO_2 absorbed. Recirculated slurry solids controlled at 15 ± 1%.	TCA inlet pH controlled at 5.9 ± 0.1. Override: Limestone stoichiometric ratio to be less than or equal to 1.4. Recirculated slurry solids controlled a at 15 ± 1%.	Limestone stoichiometric ratio controlled at 1.2. Recirculated slurry solids controlled at 15±1%. Effective Mg^{++} ion conc. (total ppm Mg^{++} - ppm Cl^-/2.92) controlled at 5000 ppm. Hold tank (D-204) with external downcomer was used.
Run Philosophy	Air flow to sparger turned off to determine the natural oxidation level without forced oxidation.	To observe whether good sulfite oxidation could be achieved with limestone addition and air sparging in the same tank.	To observe whether good sulfite oxidation could be achieved at the higher oxidation tank pH of 5.9.	The purpose of this run was to observe if near complete sulfite oxidation could be achieved with single stage forced oxidation and 5000 ppm effective Mg^{++} ion conc., and also to observe the effect of forced oxd. on SO_2 removal (cf. 591-2A).
Results	Average sulfite oxidation was 24%. SO_2 removal was 82% with an inlet SO_2 concentration of 3100 ppm. Limestone utilization was 81%. The mist eliminator was entirely clean at the end of the run.	Sulfite oxidation averaged 94%. SO_2 removal was 76% at 2800 ppm inlet SO_2 concentration. Limestone utilization was 77%. The scrubber was not shut down at the end of the run.	Sulfite oxidation averaged 92%. Average oxidation tank pH (scrubber inlet pH) was only 5.74. A desired pH of 5.9 could not be achieved without excessively high limestone stoichiometric ratio. SO_2 removal was 79% at 2400 ppm inlet SO_2 concentration. Limestone utilization was 72%. The mist eliminator was entirely clean at the end of the run.	Sulfite oxidation averaged 95%. SO_2 removal was 84% at 2500 ppm inlet SO_2 concentration. Limestone utilization was 79%. The effective Mg^{++} ion concentration was 4900 ppm. The mist eliminator was 1.8% restricted at the end of the run.

Table H-10

SUMMARY OF FLUE GAS CHARACTERIZATION TESTS ON THE TCA SYSTEM

Run Number	TFG-2F	TFG-2A
Start-of-Run Date	2/21/77	2/28/77
End-of-Run Date	2/28/77	3/ 3/77
On Stream Hours	112	76
Fly Ash	Yes	Yes
MgO Addition	No	Yes
Gas Rate, acfm @ 300°F	30,000	30,000
Gas Velocity, fps @ 125°F	12.5	12.5
Liquor Rate, gpm	1200	1200
L/G, gal/Mcf	50	50
Percent Solids Recirculated	14.1 - 16.2	13.5 - 18.0
Effluent Residence Time, min.	12 (3 tanks)	12
Stoichiometric Ratio, moles Ca added/mole SO_2 absorbed	1.15 - 1.25	1.12 - 1.42 [a]
Avg. % Limestone Utilization, 100x moles SO_2 abs./mole Ca added	83	79 [a]
Inlet SO_2 Concentration, ppm	2500 - 3600	2700 - 3300
Percent SO_2 Removal	70 - 78	90 - 98
Scrubber Inlet pH Range	5.55 - 5.85	5.2 - 5.7
Scrubber Outlet pH Range	5.05 - 5.35	4.9 - 5.6
Inlet O_2 Concentration, vol. %	5.7 - 9.2	7.9 - 10.2
Percent Sulfite Oxidized	9 - 27	8 - 16
Solids Disposal System	Clarifier	Centrifuge
Solids in Sludge Discharged, %	34 - 42	50 - 55
Calculated Avg.% Gypsum Sat'n. in Scrubber Inlet Liquor @ 50°C	100	35
Total Dissolved Solids, ppm	6800 - 8600	42,000 - 56,000
Total ΔP Range, Excluding Mist Elimination System, in. H_2O	5.8 - 7.7	5.9 - 7.3
Mist Elimination System ΔP Range, in. H_2O	0.43 - 0.49	0.44 - 0.50
Mist Elimination System Configuration	3-pass, open vane, 316L SS chevron mist eliminator.	3-pass, open-vane, 316L SS chevron mist eliminator.
Absorbent	Limestone slurried to 60 wt % with makeup water and added to first effluent hold tank.	Limestone slurried to 60 wt % with makeup water and added to EHT. MgO dry fed to EHT.
Mist Eliminator Washing Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 minutes (at 0.55 gpm/sq. ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all makeup water plus necessary clarified liquor) at 0.4 gpm/sq. ft. Top and bottom washes off during flue gas sampling.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 minutes (at 0.55 gpm/sq. ft.) with 7 minutes off between nozzles. Bottom washed intermittently with makeup water at 1.5 gpm/sq. ft. for 4 minutes every hour. Bottom wash off during flue gas sampling
Scrubber Internals	3 beds (4 grids) with nominal 5 inches spheres/bed. All beds worn nitrile foam spheres from previous run. Total actual bed ht. estimated to be 15 inches.	3 beds (4 grids) with nominal 5 inches spheres/bed. All beds worn nitrile foam spheres from previous run. Total actual bed ht. estimated to be 15 inches.
System Changes Before Start of Run	(No shutdown.)	No cleaning. No changes.
Method of Control	Stoichiometric ratio controlled at 1.2 moles Ca/mole SO_2 absorbed.	Stoichiometric ratio controlled at 1.2 moles Ca/mole SO_2 absorbed. Mg ion concentration in liquor controlled at $(9000 + \frac{\text{ppm Cl}^-}{2.92})$ ppm.
Run Philosophy	Continuation of flue gas characterization test series. Same test conditions as TFG-2C (except all mist elim. washes off when sampling flue gas).	Continuation of flue gas characterization test series. To observe the effect of high total dissolved solids (MgO addition) in liquor on outlet flue gas characteristics.
Results	The SO_2 removal averaged 74% and limestone utilization 83% at an average inlet SO_2 concentration of 3050 ppm. The mist eliminator was 1.5% restricted at the end of the run. Scale and solids in horizontal section of downcomer from TCA.	SO_2 removal averaged 94% and limestone utilization 79% at an average inlet SO_2 concentration of 3000 ppm and an effective magnesium conc. of 9000 ppm. The mist elim. was <1% restricted at end of run.

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[a] Total stoich. ratio for Ca & Mg is 1.19 - 1.51 (avg. alkali util. = 74%).

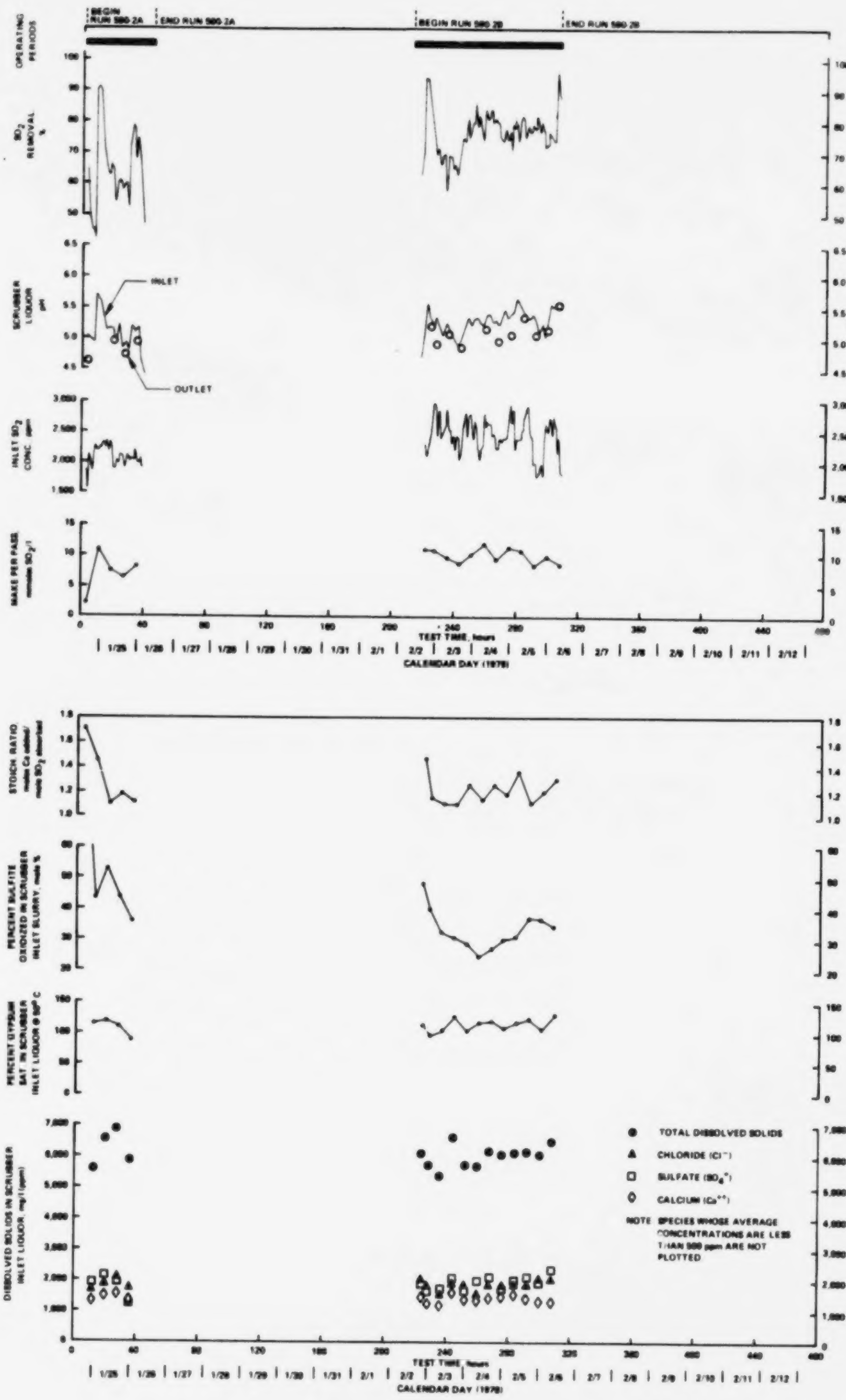
Table H-10 (continued)

SUMMARY OF FLUE GAS CHARACTERIZATION TESTS ON THE TCA SYSTEM

Run Number	TFG-2B	TFG-2C	TFG-2D	TFG-2E
Start-of-Run Date	2/4/77	2/10/77	2/14/77	2/19/77
End-of-Run Date	2/10/77	2/14/77	2/19/77	2/23/77
On Stream Hours	128	95	91	96
Fly Ash	Yes	Yes	Yes	Yes
MgO Addition	No	No	No	No
Gas Rate, acfm @ 300°F	30,000	30,000	20,000	30,000
Gas Velocity, fps @ 125°F	12.5	12.5	8.4	12.5
Liquor Rate, gpm	1200	1200	1200	600
L/G, gal/Mcf	50	50	75	25
Percent Solids Recirculated	14.5 - 15.6	14.5 - 16.1	12.8 - 15.9	11.9 - 15.1
Effluent Residence Time, min.	12 (3 tanks)	12 (3 tanks)	12 (3 tanks)	24 (3 tanks)
Stoichiometric Ratio, moles Ca added/mole SO_2 absorbed	1.1 - 1.18	1.15 - 1.35	1.15 - 1.3	1.18 - 1.25
Avg. % Limestone Utilization, 100x moles SO_2 abs./mole Ca added	88	80	82	82
Inlet SO_2 Concentration, ppm	3100 - 3700	2800 - 3900	3200 - 4100	3000 - 4000
Percent SO_2 Removal	79 - 85	75 - 86	75 - 81	50 - 54
Scrubber Inlet pH Range	5.6 - 5.8	5.7 - 5.9	5.7 - 6.0	5.65 - 5.8
Scrubber Outlet pH Range	4.8 - 5.2	5.1 - 5.4	5.25 - 5.55	5.0 - 5.2
Inlet O_2 Concentration, vol. %	5.5 - 8.5	6.5 - 9.2	6.9 - 8.5	7.0 - 8.5
Percent Sulfite Oxidized	6 - 16	5 - 16	6 - 16	4 - 23
Solids Disposal System	Clarifier	Clarifier	Clarifier	Clarifier
Solids in Sludge Discharged, %	30 - 39	32 - 42	35 - 42	37 - 41
Calculated Avg. % Gypsum Sat'n. in Scrubber Inlet Liquor @ 50°C	105	75	95	55
Total Dissolved Solids, ppm	7400 - 9800	5400 - 9400	5800 - 7200	4900 - 5900
Total ΔP Range, Excluding Mist Elimination System, in. H_2O	8.6 - 9.8	7.6 - 9.5	4.6 - 5.0	4.7 - 5.1
Mist Elimination System ΔP Range, in. H_2O	0.56 - 0.60	0.49 - 0.60	0.17 - 0.24	0.49 - 0.56
Mist Elimination System Configuration	3-pass, open-vane, 316L SS chevron mist eliminator.	3-pass, open-vane, 316L SS chevron mist eliminator.	3-pass, open-vane, 316L SS chevron mist eliminator.	3-pass, open-vane, 316L SS chevron mist eliminator.
Absorbent	Limestone slurried to 60 wt % with makeup water and added to first effluent hold tank.	Limestone slurried to 60 wt % with makeup water and added to first effluent hold tank.	Limestone slurried to 60 wt % with makeup water and added to first effluent hold tank.	Limestone slurried to 60 wt % with makeup water and added to first effluent hold tank.
Mist Eliminator Washing Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 minutes (at 0.55 gpm/sq. ft.) with 7 min. off between nozzles. Bottom washed intermittently with makeup water at 1.5 gpm/sq. ft. for 4 minutes every hour. Bottom wash off during flue gas sampling.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 minutes (at 0.55 gpm/sq. ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all makeup water plus necessary clarified liquor) at 0.4 gpm/sq. ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 minutes (at 0.55 gpm/sq. ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all makeup water plus necessary clarified liquor) at 0.4 gpm/sq. ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 minutes (at 0.55 gpm/sq. ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all makeup water plus necessary clarified liquor) at 0.4 gpm/sq. ft.
Scrubber Internals	3 beds (4 grids) with nominal 5 inches spheres/bed. Top bed worn nitrile foam spheres from Run 706-2A. Middle and bottom beds replaced by 5000 new nitrile foam shperes/bed. Total actual bed ht. estimated to be 15 inches.	3 beds (4 grids) with nominal 5 inches spheres/bed. All beds worn nitrile foam spheres from previous run. Total actual bed ht. estimated to be 15 inches.	3 beds (4 grids) with nominal 5 inches spheres/bed. All beds worn nitrile foam spheres from previous run. Total actual bed ht. estimated to be 15 inches.	3 beds (4 grids) with nominal 5 inches spheres/bed. All beds worn nitrile foam spheres from previous run. Total actual bed ht. estimated to be 15 inches.
System Changes before Start of Run	No cleaning. Middle and bottom beds replaced by 5000 new spheres/bed.	No cleaning. No changes.	No cleaning. No changes.	(No shutdown.)
Method of Control	Stoichiometric ratio controlled at 1.2 moles Ca/mole SO_2 absorbed.	Stoichiometric ratio controlled at 1.2 moles Ca/mole SO_2 absorbed.	Stoichiometric ratio controlled at 1.2 moles Ca/mole SO_2 absorbed.	Stoichiometric ratio controlled at 1.2 moles Ca/mole SO_2 absorbed.
Run Philosophy	First run of a planned flue gas characterization test series to obtain data on simultaneous inlet and outlet mass loading, SO_3 and particulate size distribution.	Continuation of flue gas characterization test series. Test conditions same as Run TFG-2B except using continuous mist eliminator bottom wash.	Continuation of flue gas characterization test series. To observe the effect of low gas rate on flue gas characteristics at the inlet and outlet of the scrubber.	Continuation of flue gas characterization test series. To observe the effect of low liquor rate on flue gas characteristics at the inlet and outlet of the scrubber.
Results	SO_2 removal averaged 82% and limestone utilization 88% at an average inlet SO_2 concentration of 3400 ppm. The mist eliminator was cleaned at 86 hrs when 40% restricted due to high stoichiometry excursion. At end of run after another 42 hrs it was 2% restricted.	SO_2 removal averaged 81% and limestone utilization 80% at an average inlet SO_2 concentration of 3350 ppm. The mist eliminator was 1% restricted at the end of the run.	SO_2 removal averaged 78% and limestone utilization 82% at an average inlet SO_2 concentration of 3650 ppm. The scrubber was not shut down at the end of the run.	SO_2 removal averaged 52% and limestone utilization 82% at an average inlet SO_2 concentration of 3500 ppm. The scrubber was not shut down at the end of the run.

APPENDIX I

GRAPHICAL OPERATING DATA FROM THE TCA TESTS



590 - 2A

Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec @ 125° F
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
EHT Residence Time = 4.1 min
3 Beds, 5 in. spheres/bed
Percent Solids Recirculated = 13.2 - 14.5 wt %
Total Pressure Drop, Excluding Mist Elim. = 10.2 - 12.5 in. H_2O
Mist Elim. Pressure Drop = 0.40 - 0.48 in. H_2O
Discharge (Clarifier & Centrifuge) Solids Concentration = 62 - 70 wt %
Limestone Addition to Downcomer
External Downcomer used

590 - 2B

Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec @ 125° F
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
EHT Residence Time = 4.1 min
3 Beds, 5 in. spheres/bed
Percent Solids Recirculated = 13.5 - 15.9 wt %
Total Pressure Drop, Excluding Mist Elim. = 9.5 - 11.5 in. H_2O
Mist Elim. Pressure Drop = 0.42 - 0.52 in. H_2O
Discharge (Clarifier & Centrifuge) Solids Concentration = 56 - 80 wt %
Limestone Addition to Downcomer
Internal Downcomer used

Figure I-1. OPERATING DATA FOR TCA RUNS 590-2A AND 590-2B

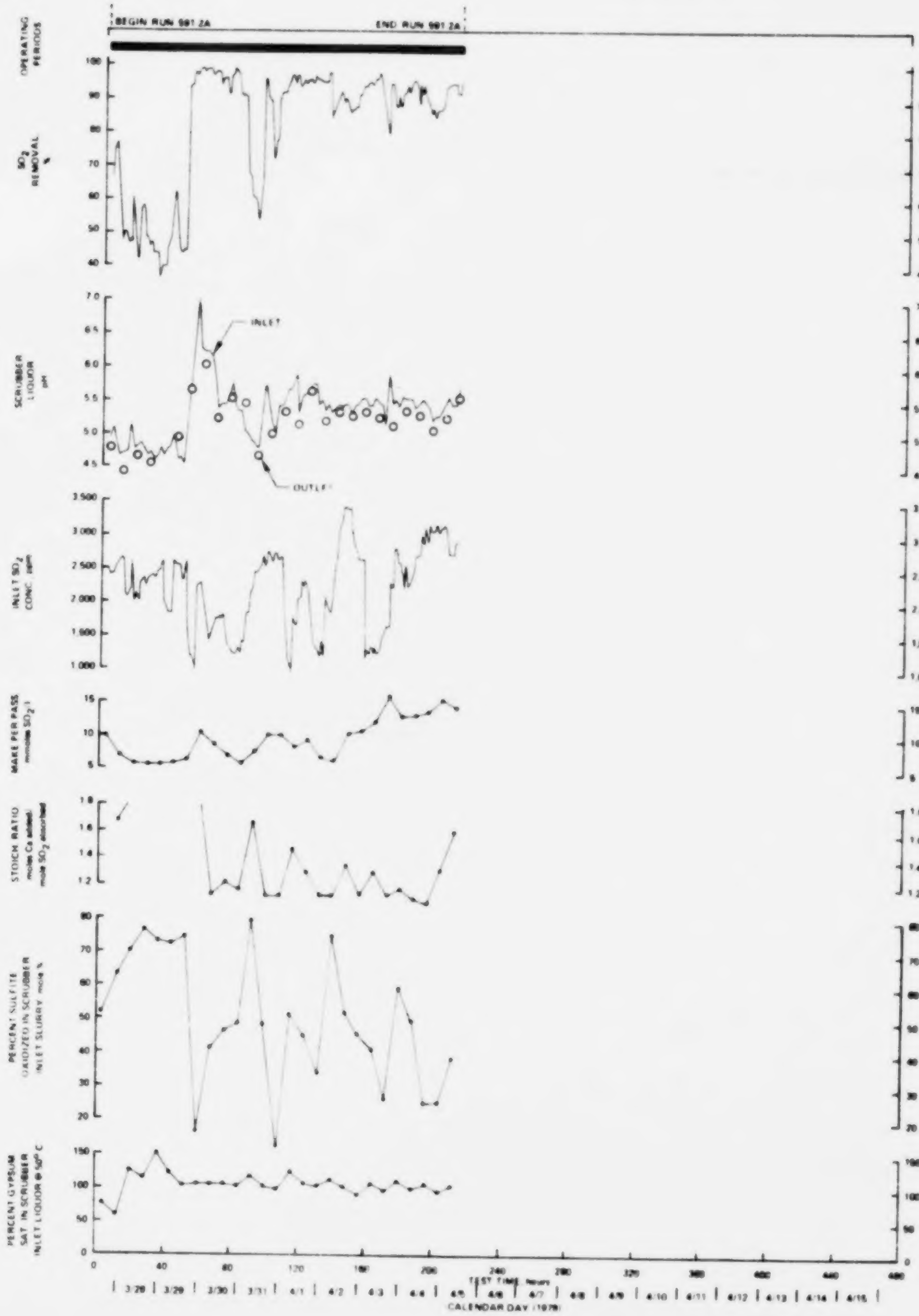
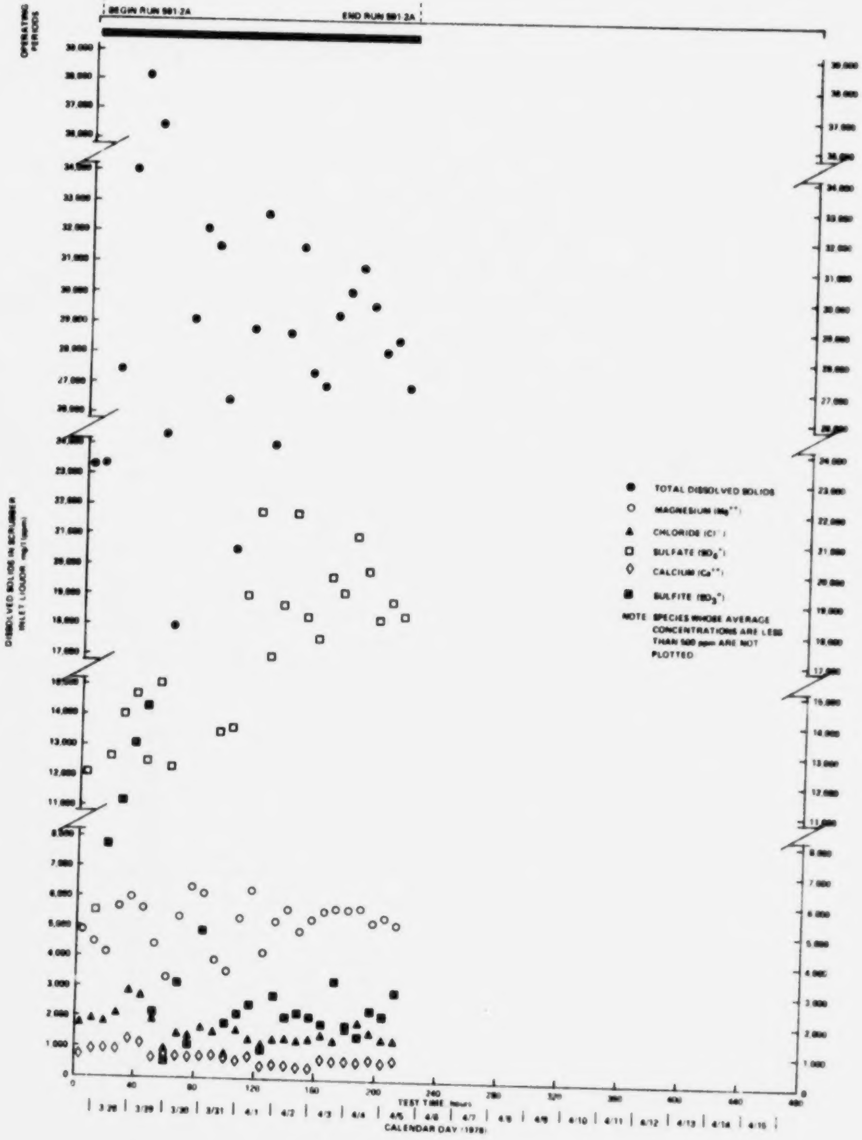


Figure I-2. OPERATING DATA FOR TCA RUN 591-2A



Gas Rate = 30,000 acfm @ 300° F

Gas Velocity = 12.5 ft/sec @ 125° F

Liquor Rate = 1200 gpm

L/G = 50 gal/Mcf

EHT Residence Time = 4.1 min

3 Beds, 5 in. spheres/bed

Percent Solids Recirculated = 13.1 - 15.7 wt %

Total Pressure Drop, Excluding Mist Elim. = 7.9 - 13.3 in. H_2O

Mist Elim. Pressure Drop = 0.45 - 0.60 in. H_2O

Discharge (Clarifier & Centrifuge) Solids Concentration = 54 - 60 wt %

Limestone Addition to EHT and MgO dry fed to EHT

External Downcomer used

Figure I-2 (continued). OPERATING DATA FOR TCA RUN 591-2A

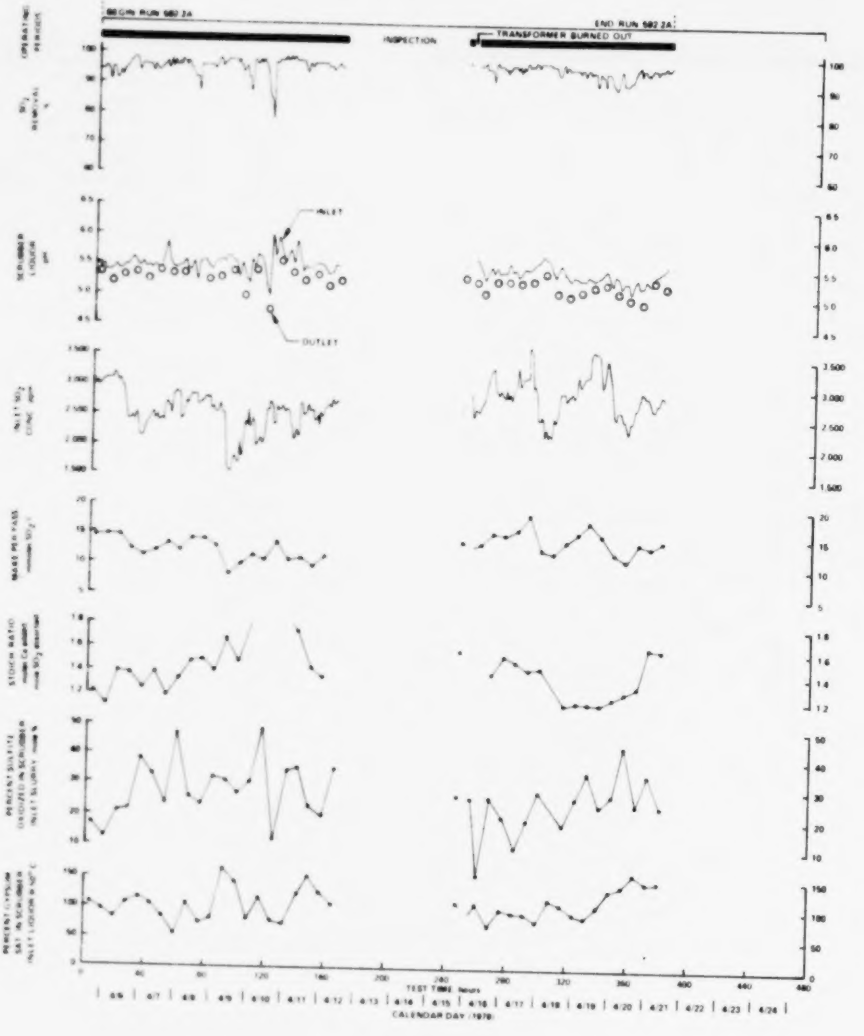
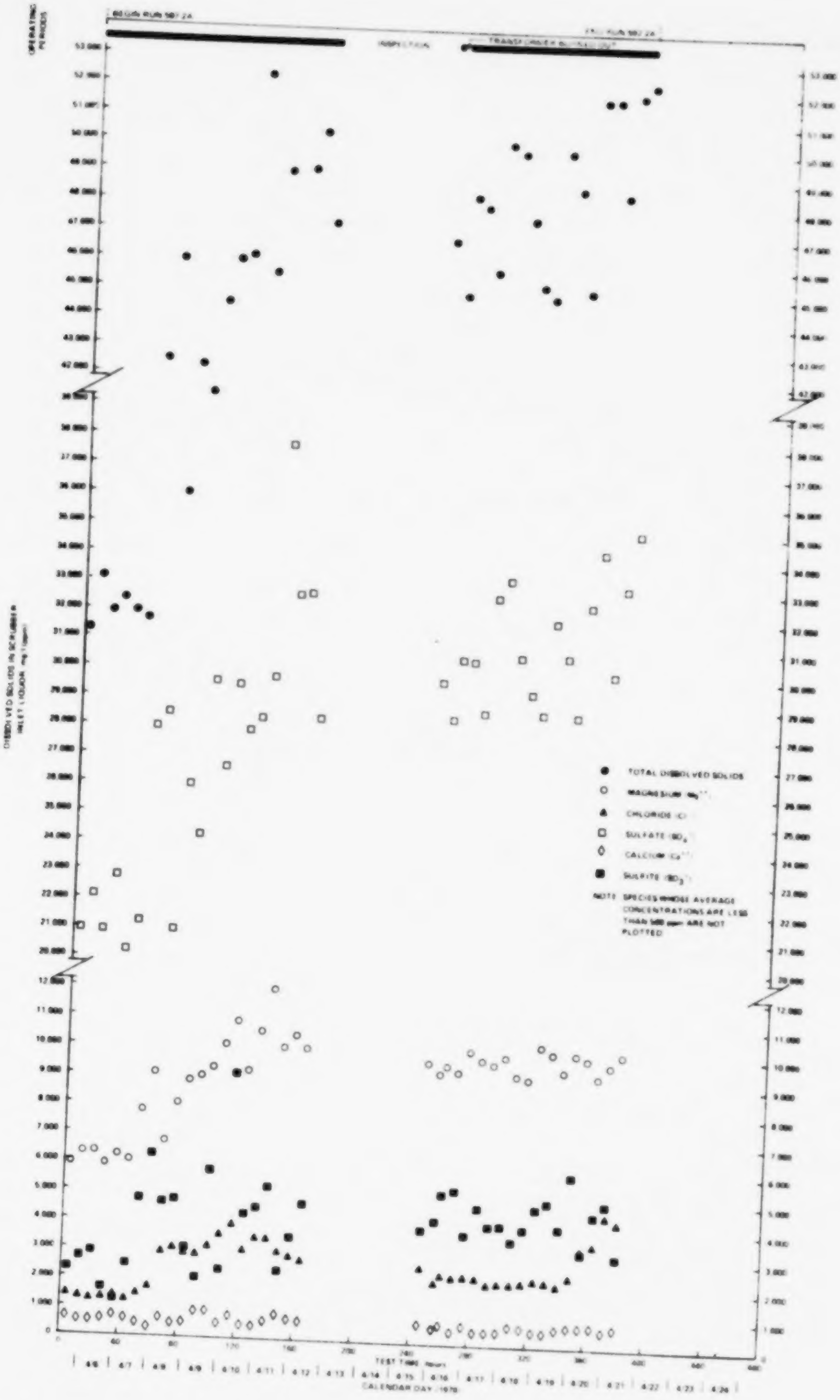


Figure I-3. OPERATING DATA FOR TCA RUN 592-2A



Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec @ 125° F
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
EHT Residence Time = 4.1 min
3 Beds, 5 in. spheres/bed
Percent Solids Recirculated = 14.3 - 15.7 wt %
Total Pressure Drop, Excluding Mist Elim.
= 7.8 - 10.0 in. H_2O
Mist Elim. Pressure Drop = 0.52 - 0.60 in. H_2O
Discharge (Clarifier & Centrifuge) Solids
Concentration = 51 - 59 wt %
Limestone Addition to EHT and
MgO dry fed to EHT
External Downcomer used

Figure I-3 (continued). OPERATING DATA FOR TCA RUN 592-2A

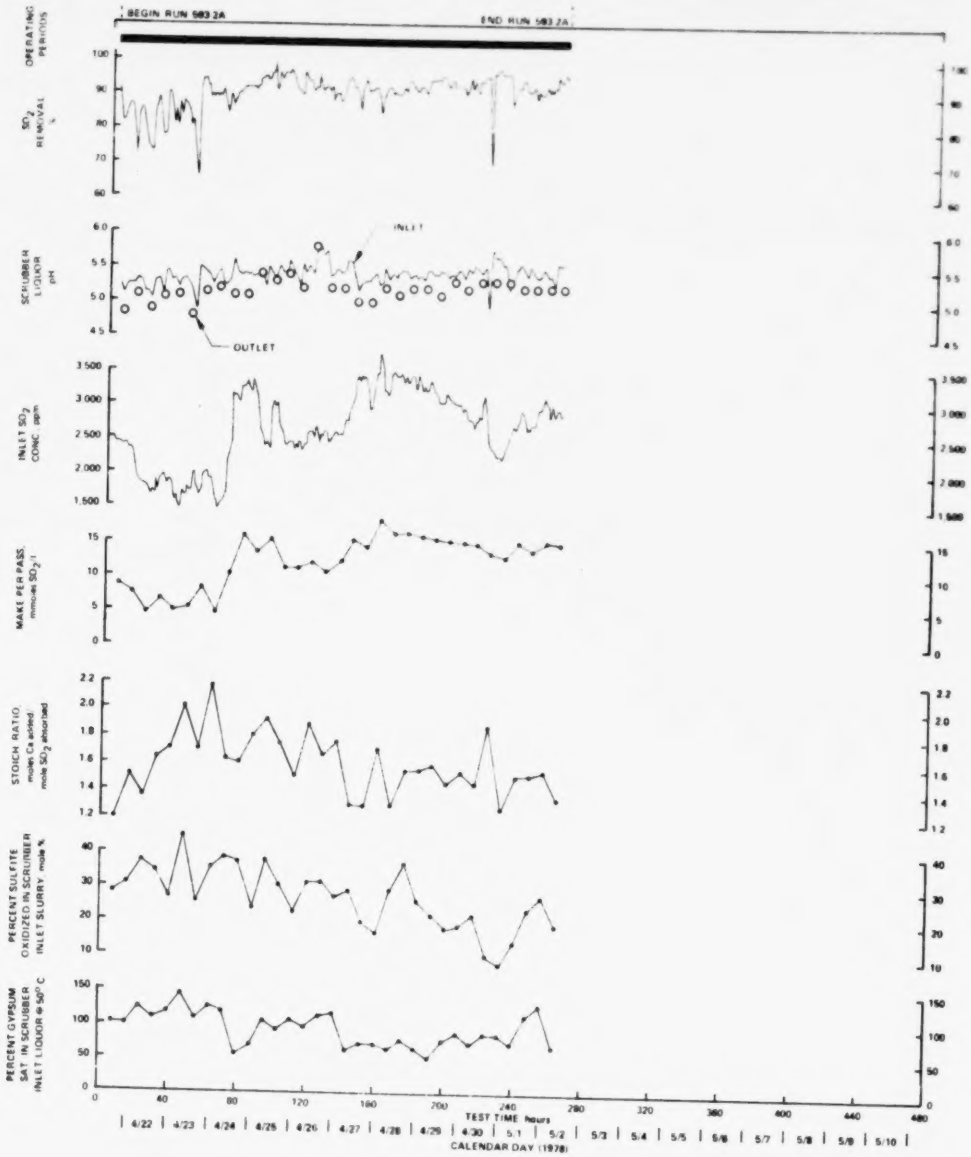
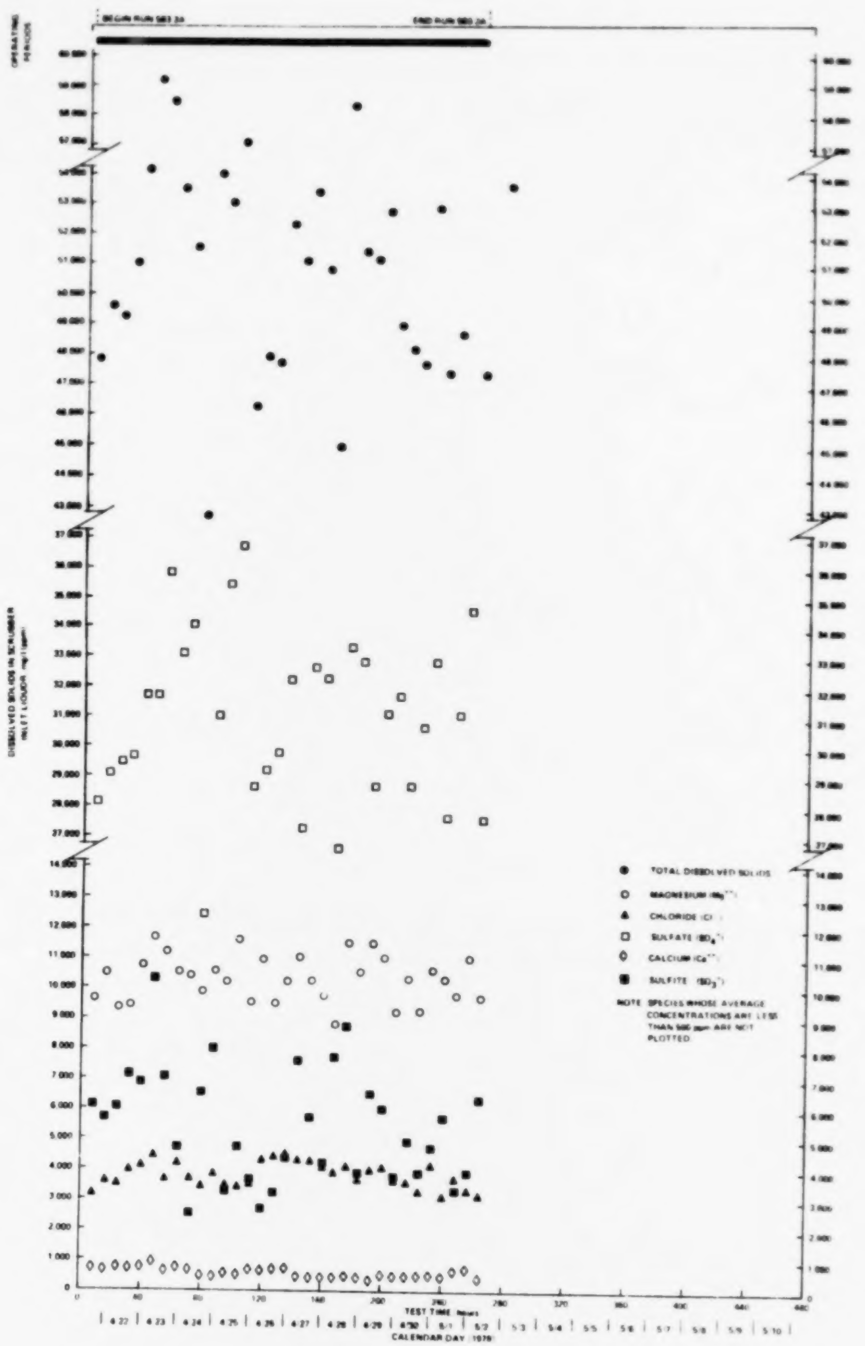
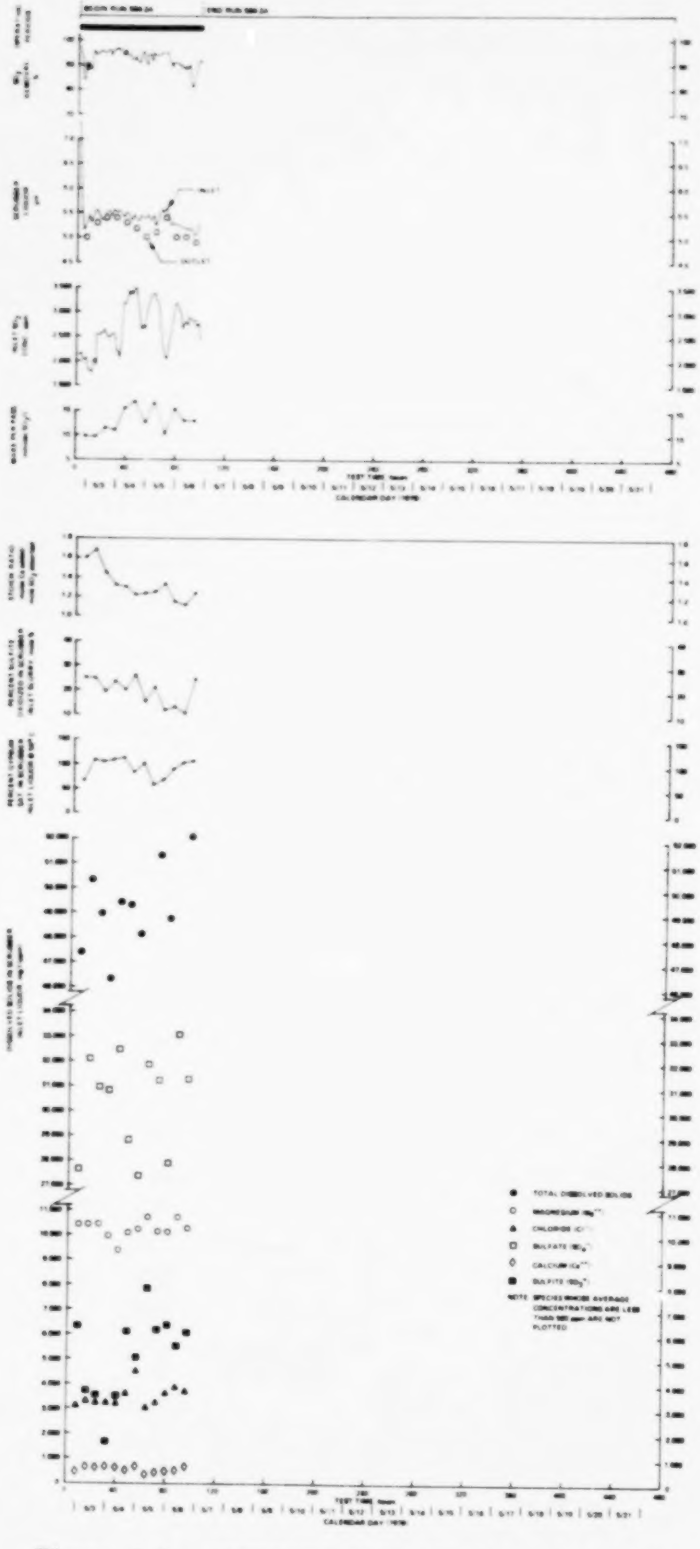


Figure I-4. OPERATING DATA FOR TCA RUN 593-2A



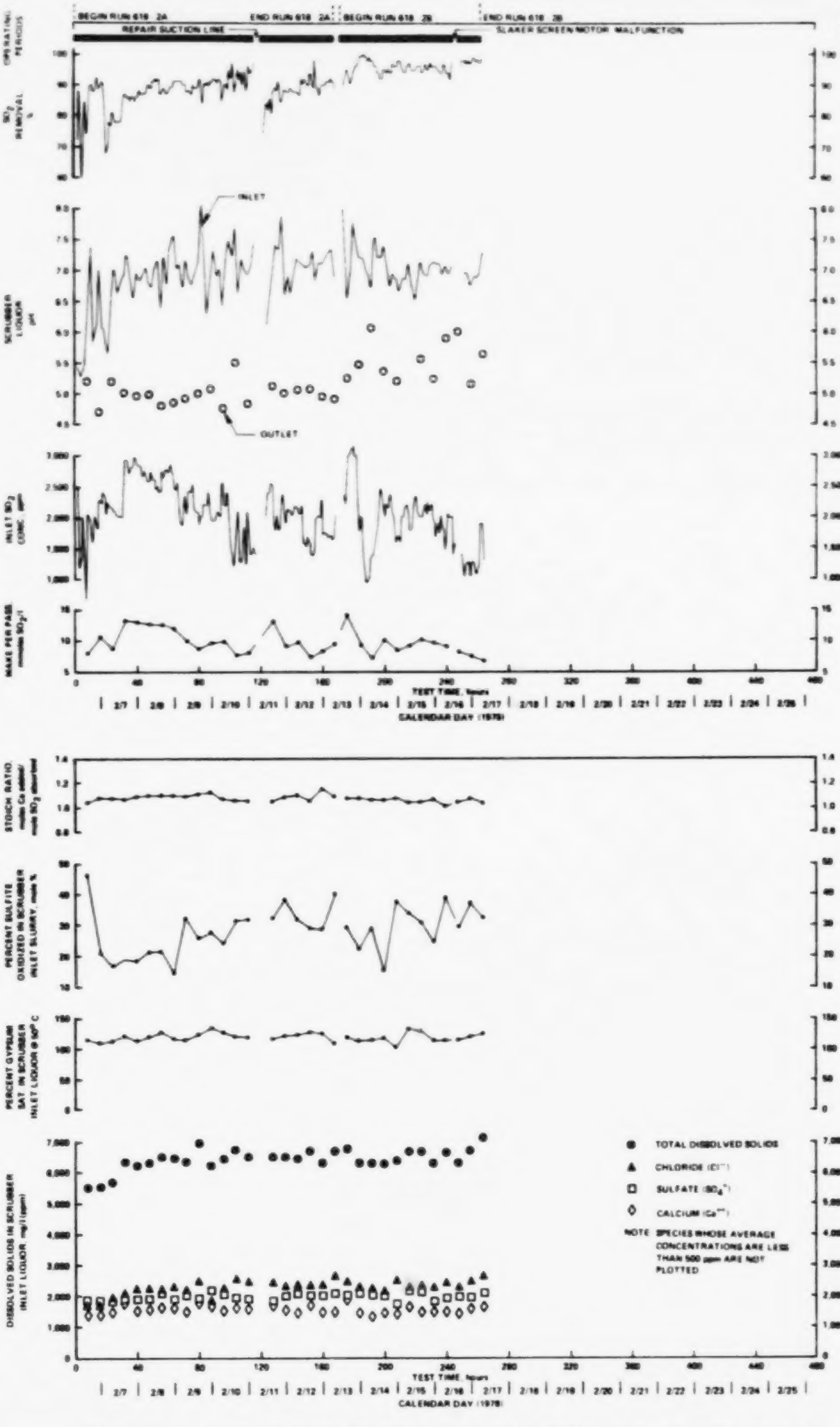
Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec @ 125° F
Liquor Rate = 900 gpm
L/G = 37 gal/Mcf
EHT Residence Time = 4.1 min
3 Beds, 5 in. spheres/bed
Percent Solids Recirculated = 14.0 - 15.6 wt %
Total Pressure Drop, Excluding Mist Elim.
= 6.6 - 7.8 in. H_2O
Mist Elim. Pressure Drop = 0.49 - 0.66 in. H_2O
Discharge (Clarifier & Centrifuge) Solids
Concentration = 52 - 62 wt %
Limestone Addition to EHT and
MgO dry fed to EHT
External Downcomer used

Figure I-4 (continued). OPERATING DATA FOR TCA RUN 593-2A



Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec @ 125° F
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
EHT Residence Time = 4.1 min
3 Beds, 5 in. spheres/bed
Percent Solids Recirculated = 13.9 - 16.3 wt %
Total Pressure Drop, Excluding Mist Elim.
= 7.2 - 8.8 in. H_2O
Mist Elim. Pressure Drop = 0.51 - 0.56 in. H_2O
Discharge (Clarifier & Centrifuge) Solids
Concentration = 53 - 54 wt %
Limestone and Dry MgO Addition to EHT
Internal Downcomer Used

Figure I-5. OPERATING DATA FOR TCA RUN 594-2A



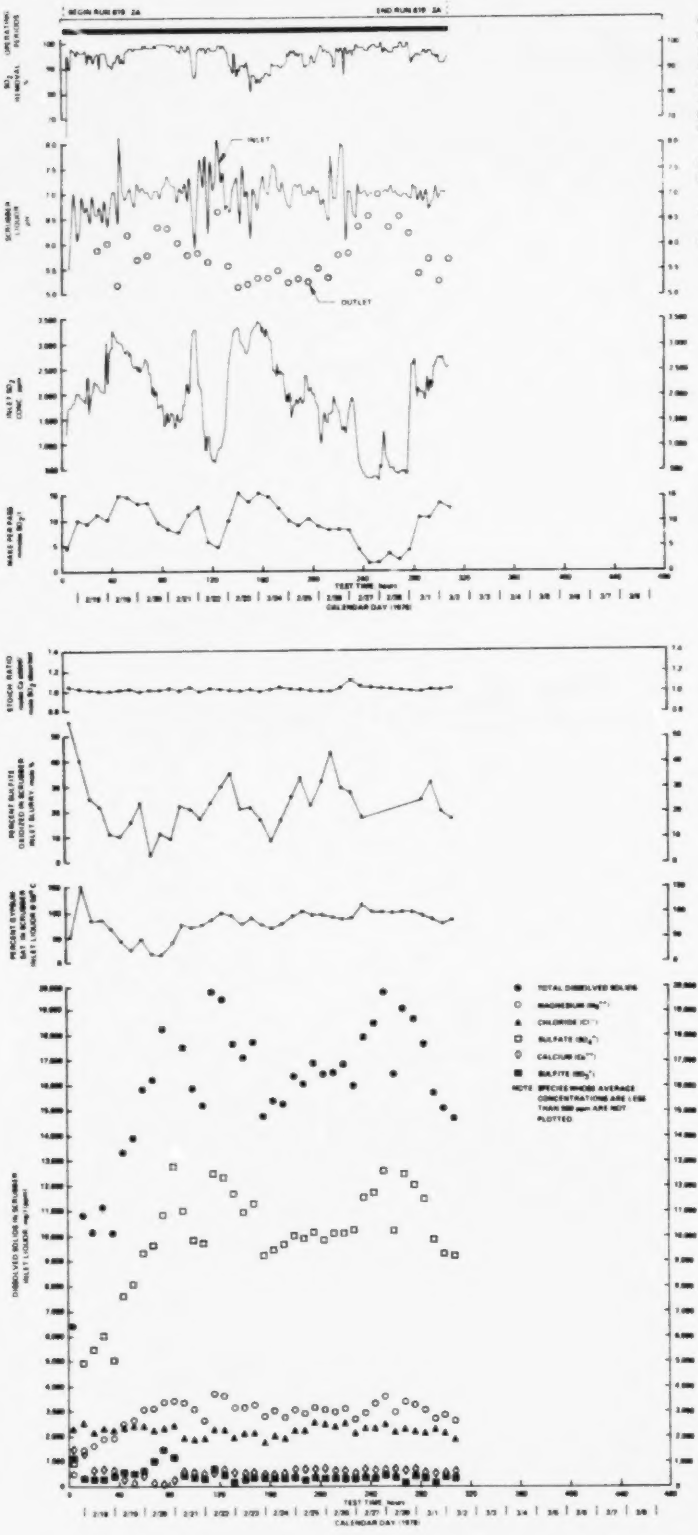
618 - 2A

Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec @ 125° F
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
EHT Residence Time = 4.1 min
3 Beds, 5 in. spheres/bed
Percent Solids Recirculated = 6.5 - 9.1 wt %
Total Pressure Drop, Excluding Mist Elim.
= 8.6 - 13.5 in. H_2O
Mist Elim. Pressure Drop = 0.40 - 0.52 in. H_2O
Discharge (Clarifier & Centrifuge) Solids
Concentration = 60 - 65 wt %
Lime Addition to Downcomer
Internal Downcomer used

618 - 2B

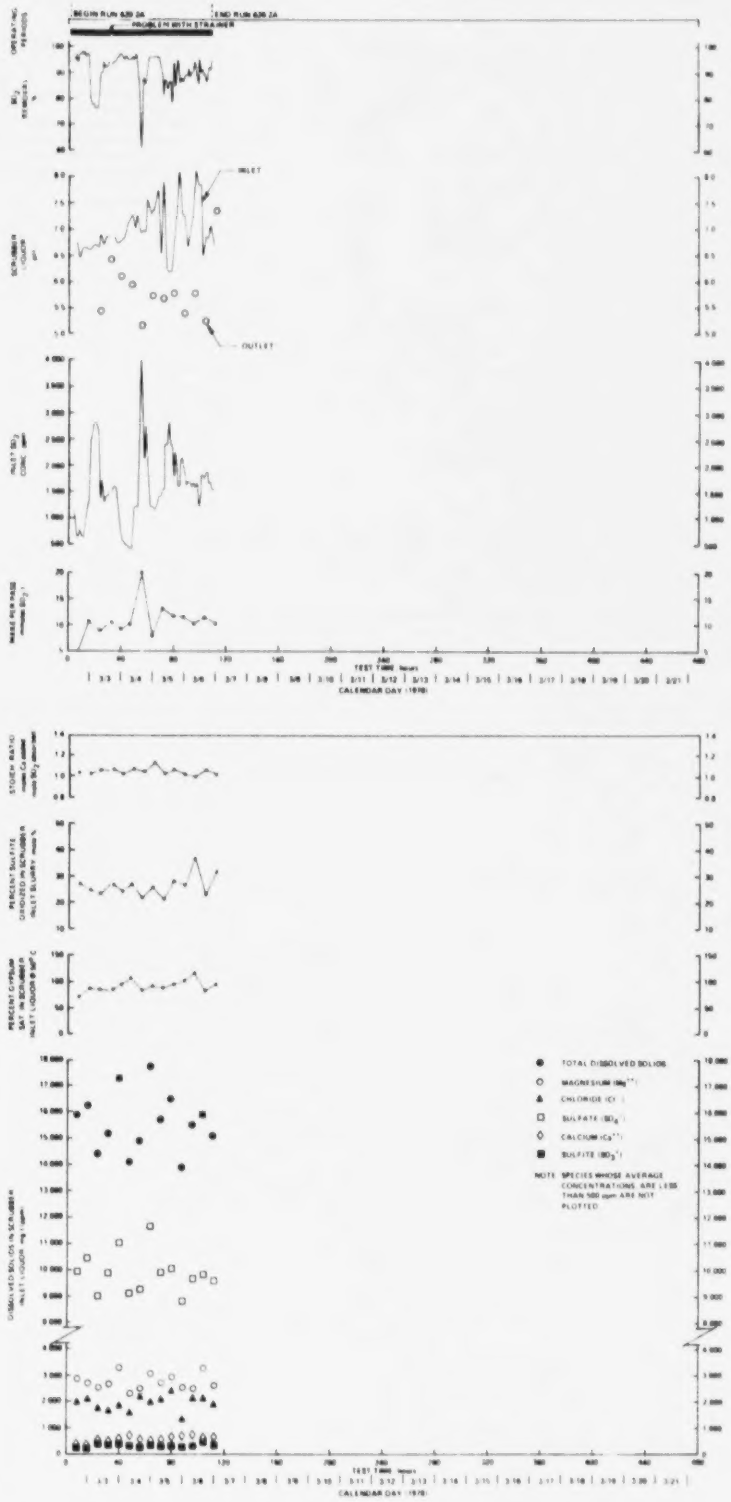
Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec @ 125° F
Liquor Rate 1200 gpm
L/G = 50 gal/Mcf
EHT Residence Time = 4.1 min
3 Beds, 5 in. spheres/bed
Percent Solids Recirculated = 6.5 - 8.5 wt %
Total Pressure Drop, Excluding Mist Elim.
= 11.1 - 15.5 in. H_2O
Mist Elim. Pressure Drop = 0.46 - 0.58 in. H_2O
Discharge (Clarifier & Centrifuge) Solids
Concentration = 55 - 63 wt %
Lime Addition to Downcomer
External Downcomer used

Figure I-6. OPERATING DATA FOR TCA RUNS 618-2A AND 618-2B



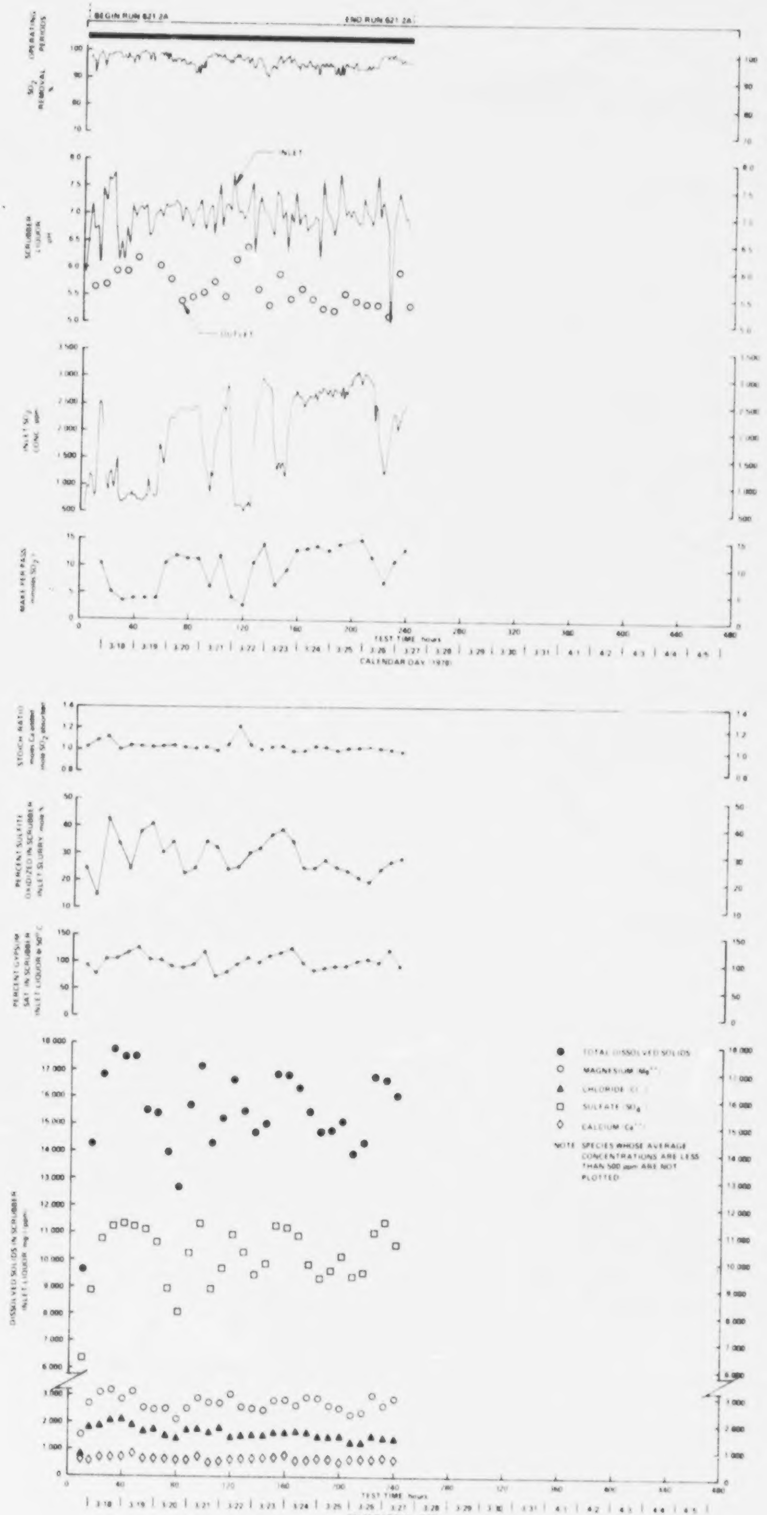
Gas Rate = 30,000 acfm 300° F
Gas Velocity = 12.5 ft/sec @ 125° F
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
EHT Residence Time = 4.1 min
3 Beds, 5 in. spheres/bed
Percent Solids Recirculated = 7.3 - 8.8 wt %
Total Pressure Drop, Excluding Mist Elim.
= 8.5 - 11.3 in. H_2O
Mist Elim. Pressure Drop = 0.28 - 0.56 in. H_2O
Discharge (Clarifier & Centrifuge) Solids
Concentration = 48 - 82 wt %
Lime Addition to Downcomer and MgO dry
fed to EHT
External Downcomer used

Figure I-7. OPERATING DATA FOR TCA RUN 619-2A



Gas Rate - 30,000 acfm @ 300° F
Gas Velocity - 12.5 ft/sec @ 125° F
Liquor Rate - 900 gpm
L/G - 37 gal/Mcf
EHT Residence Time - 4.1 min
3 Beds, 5 in. spheres/bed
Percent Solids Recirculated - 6.8-9.3 wt %
Total Pressure Drop, Excluding Mist Elim.
= 7.3-9.0 in. H_2O
Mist Elim. Pressure Drop - 0.46-0.62 in. H_2O
Discharge (Clarifier & Centrifuge) Solids
Concentration - 52-60 wt %
Lime Addition to Downcomer and
MgO dry fed to EHT
External Downcomer used

Figure I-8. OPERATING DATA FOR TCA RUN 620-2A



Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec @ 125° F
Liquor Rate ≅ 1200 gpm
L/G = 50 gal/Mcf
EHT Residence Time = 3.0 min
3 Beds, 5 in. spheres/bed
Percent Solids Recirculated = 6.6-9.6 wt %
Total Pressure Drop, Excluding Mist Elim.
= 9.1-12.6 in. H_2O
Mist Elim. Pressure Drop = 0.50-0.64 in. H_2O
Discharge (Clarifier & Centrifuge) Solids
Concentration = 48-62 wt %
Lime Addition to Downcomer and
MgO dry fed to EHT
External Downcomer used

Figure I-9. OPERATING DATA FOR TCA RUN 621-2A

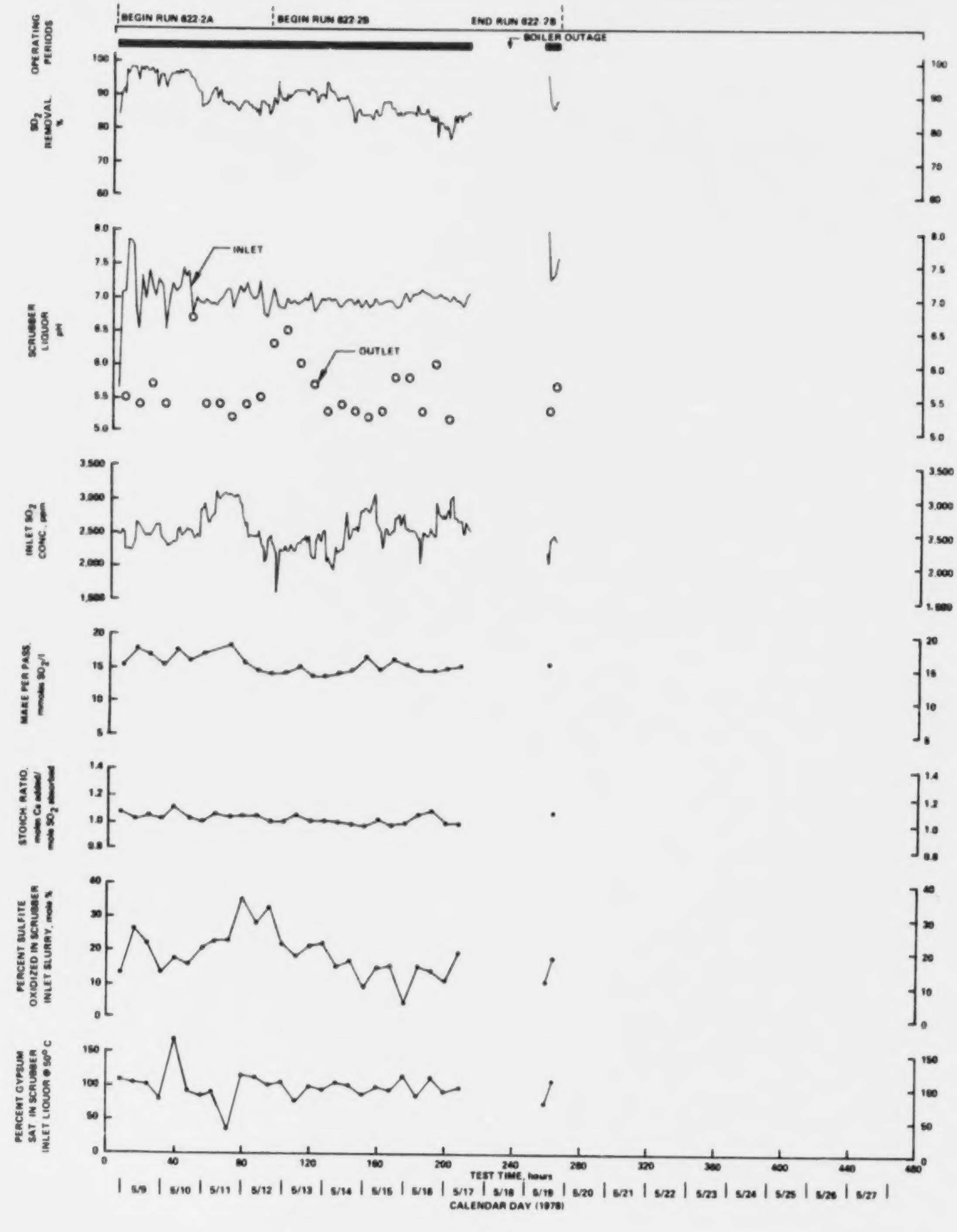
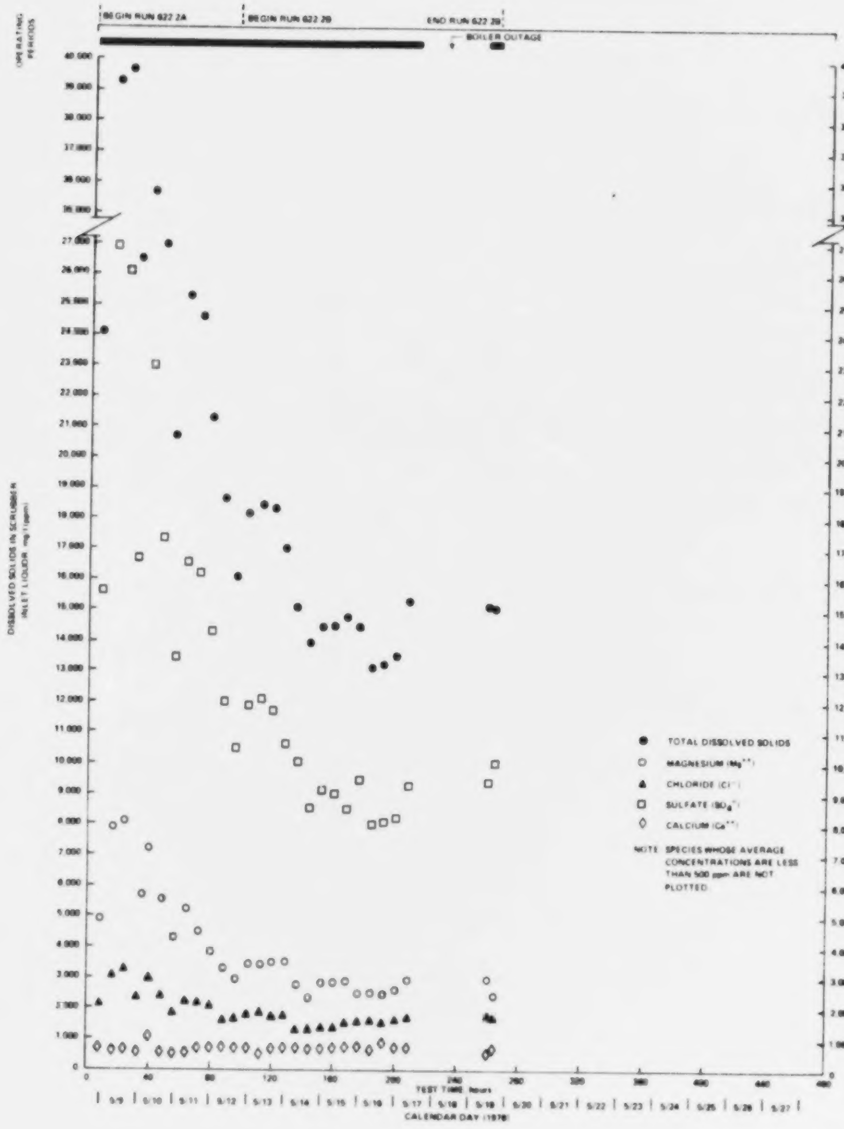


Figure I-10. OPERATING DATA FOR TCA RUNS 622-2A AND 622-2B



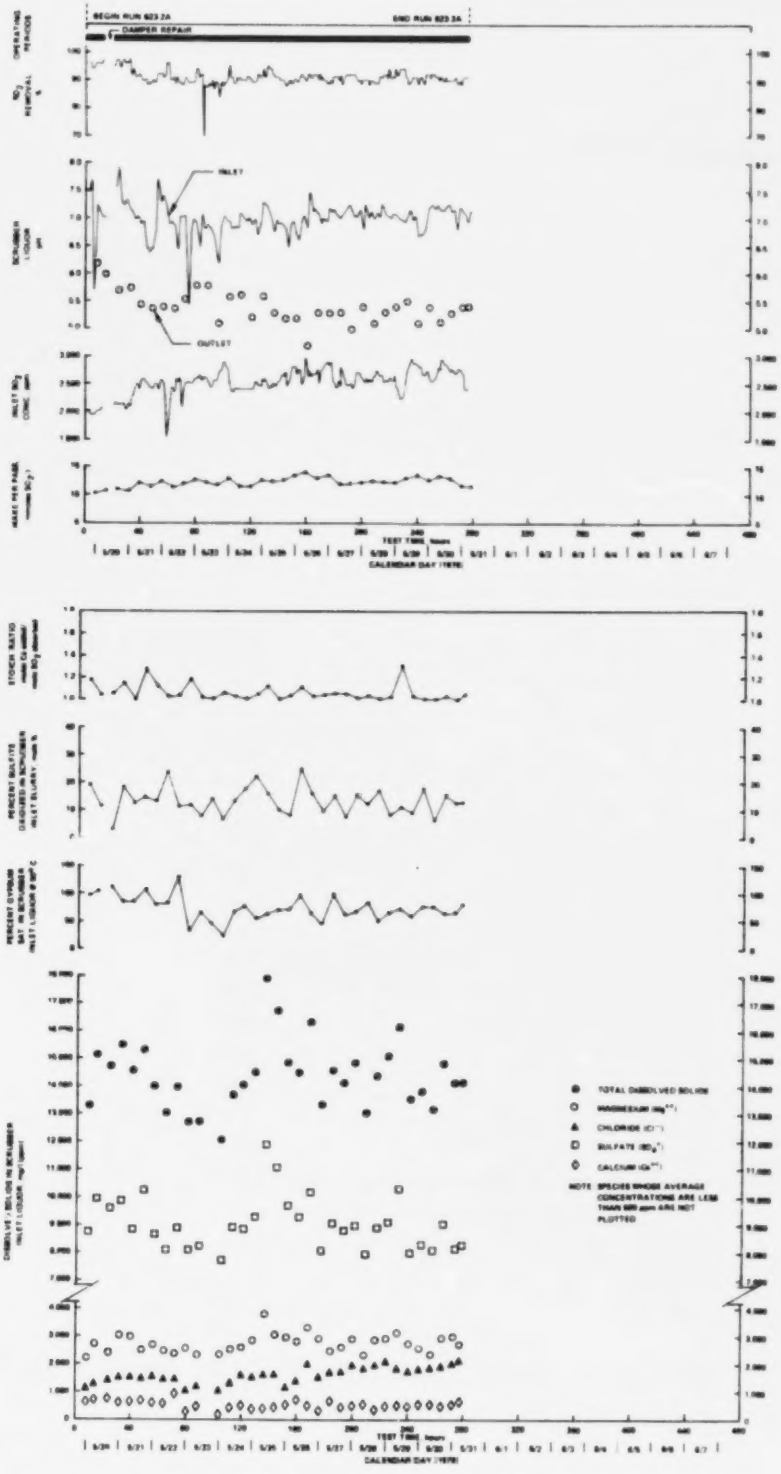
622-2A

Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec @ 125° F
Liquor Rate = 900 gpm
L/G = 37 gal/Mcf
EHT Residence Time = 4.1 min
3 Beds, 5 in. spheres/bed
Percent Solids Recirculated = 7.7-9.5 wt %
Total Pressure Drop, Excluding Mist Elim.
= 6.3-7.0 in. H_2O
Mist Elim. Pressure Drop = 0.50-0.59 in. H_2O
Discharge (Clarif./Clarif. & Centrifuge) Solids
Concentration = 37-39/52-58 wt %
Lime and Dry MgO Addition to EHT
External Downcomer Used

622-2B

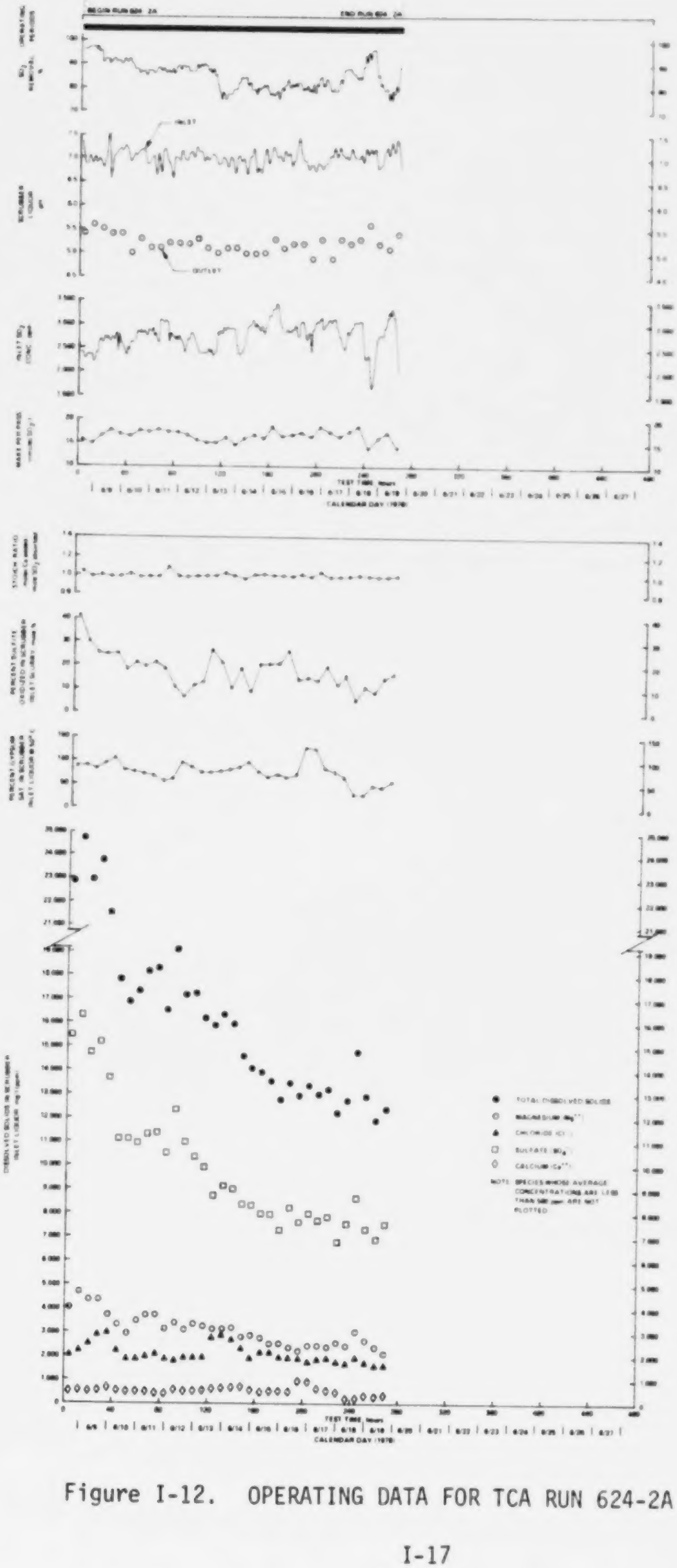
Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec @ 125° F
Liquor Rate = 900 gpm
L/G = 37 gal/Mcf
EHT Residence Time = 4.1 min
3 Beds, 5 in. spheres/bed
Percent Solids Recirculated = 7.3-8.7 wt %
Total Pressure Drop, Excluding Mist Elim.
= 6.2-7.2 in. H_2O
Mist Elim. Pressure Drop = 0.51-0.60 in. H_2O
Discharge (Clarif./Clarif. Centrifuge) Solids
Concentration = 37-47/60-61 wt %
Lime and Dry MgO Addition to EHT
External Downcomer Used

Figure I-10 (continued). OPERATING DATA FOR TCA RUNS 622-2A & 622-2B



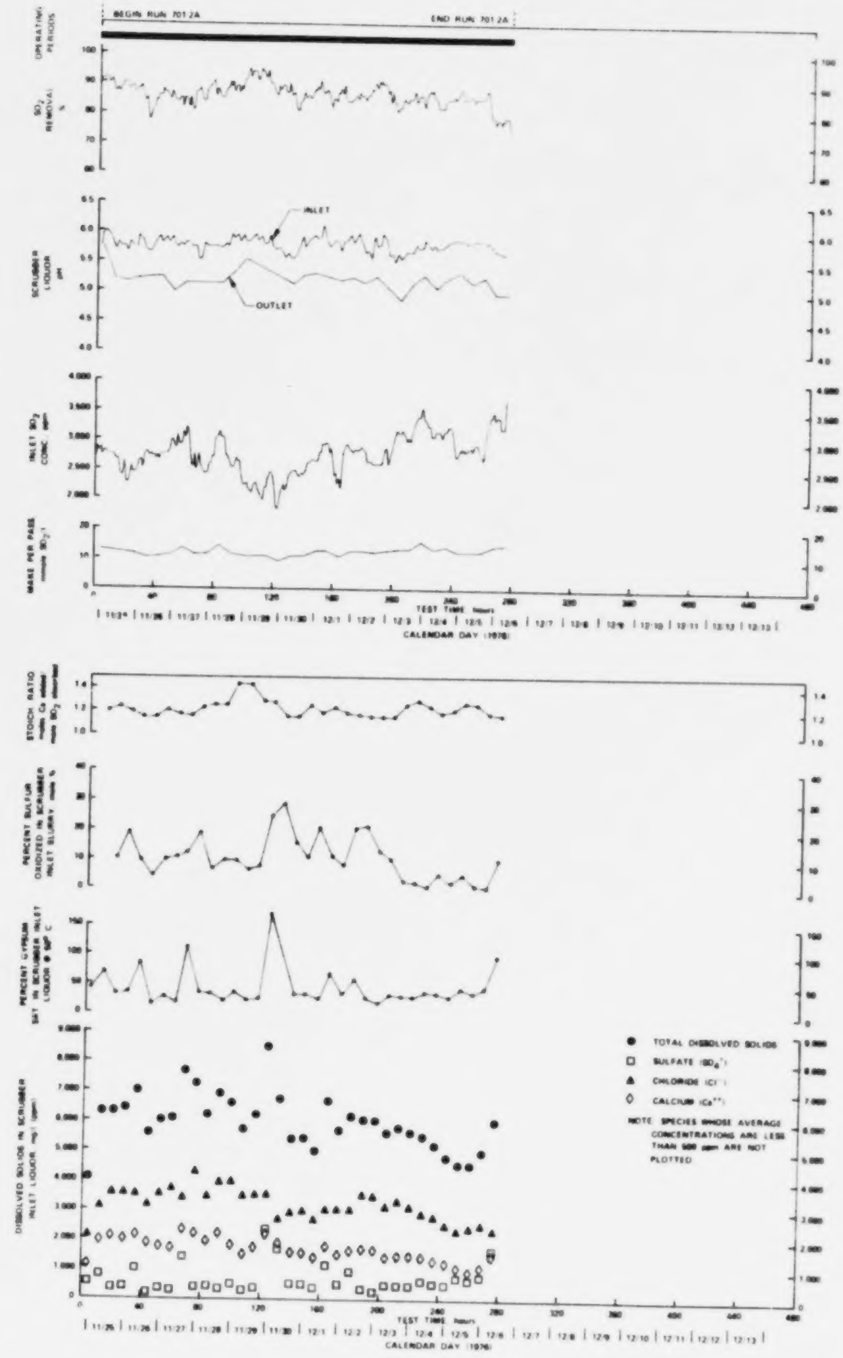
Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec @ 125° F
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
EHT Residence Time = 3.0 min
3 Beds, 5 in. spheres/bed
Percent Solids Recirculated = 7.4 - 9.0 wt %
Total Pressure Drop, Excluding Mist Elim.
= 6.4 - 7.8 in. H_2O
Mist Elim. Pressure Drop = 0.54 - 0.68 in. H_2O
Discharge (Clarifier & Centrifuge) Solids
Concentration = 53 - 65 wt %
Lime and Dry MgO Addition to EHT
External Downcomer used

Figure I-11. OPERATING DATA FOR TCA RUN 623-2A



Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec @ 125° F
Liquor Rate = 900 gpm
L/G = 37 gal/Mcf
EHT Residence Time = 3 min
3 Beds, 5 in. spheres/bed
Percent Solids Recirculated = 7.6 - 8.4 wt %
Total Pressure Drop, Excluding Mist Elim.
= 5.9 - 7.0 in. H_2O
Mist Elim. Pressure Drop = 0.63 - 0.78 in. H_2O
Discharge (Clarifier) Solids
Concentration = 35 - 49 wt %
Lime and Dry MgO Addition to EHT
External Downcomer used

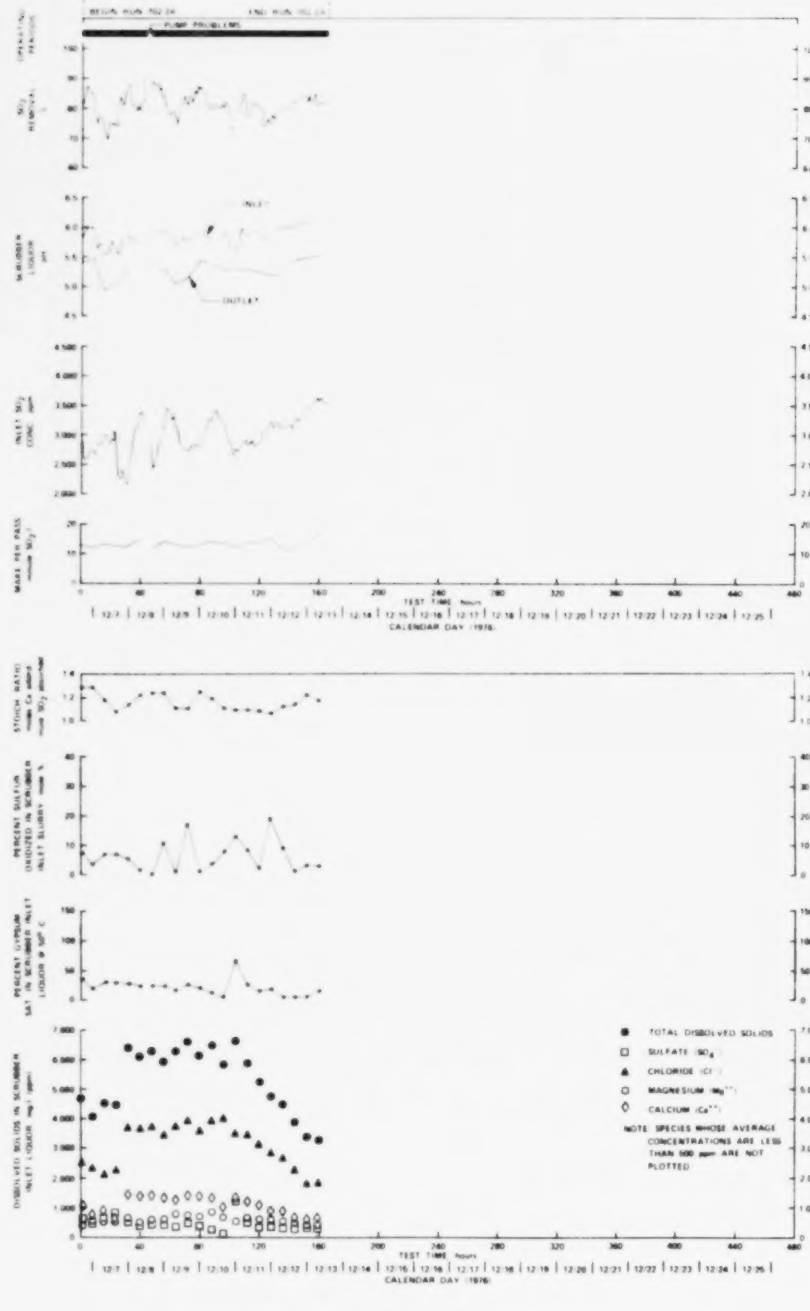
Figure I-12. OPERATING DATA FOR TCA RUN 624-2A



Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec
Liquor Rate = 1200 gpm
L/G = 50 gal/mcf
EHT Residence Time = 4.1 min
3 Beds, 5 in. spheres/bed

Percent Solids Recirculated = 7.5-8.5 wt %
Total Pressure Drop, Excluding Mist Elim.
= 7.7-8.1 in. H_2O
Mist Elim. Pressure Drop = 0.42-0.56 in. H_2O
Discharge (Clarifier & Centrifuge) Solids
Concentration = 31-43 wt %
Limestone Addition to EHT

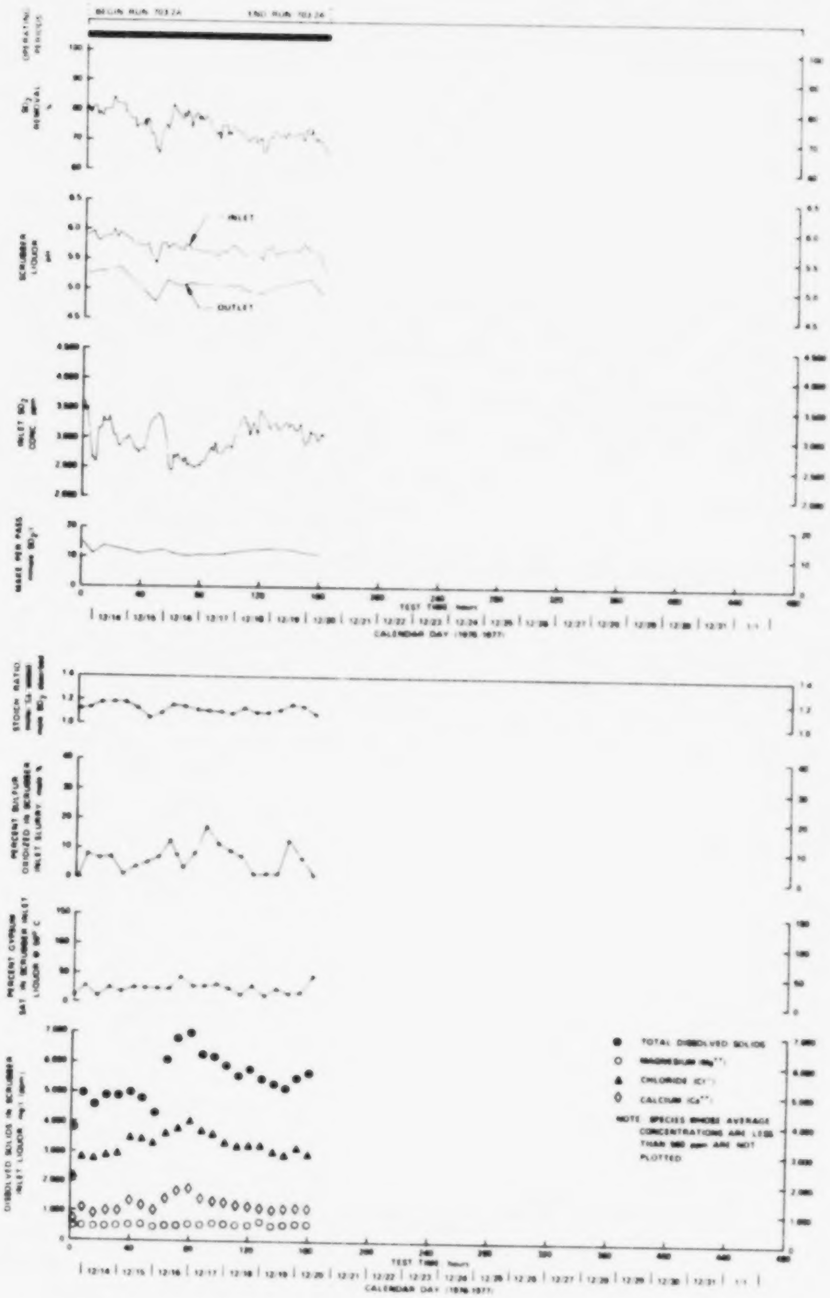
Figure I-13. OPERATING DATA FOR TCA RUN 701-2A



Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec
Liquor Rate = 1200 gpm
L/G = 50 gal/mcf
EHT Residence Time = 4.1 min
3 Beds, 4.7 in. spheres/bed

Percent Solids Recirculated = 14.3-16.1 wt %
Total Pressure Drop, Excluding Mist Elim.
= 7.5-8.0 in. H_2O
Mist Elim. Pressure Drop = 0.45-0.50 in. H_2O
Discharge (Cent. (till 12/10)/Clarifier) Solids
Concentration = 33-42 wt %
Limestone Addition to EHT

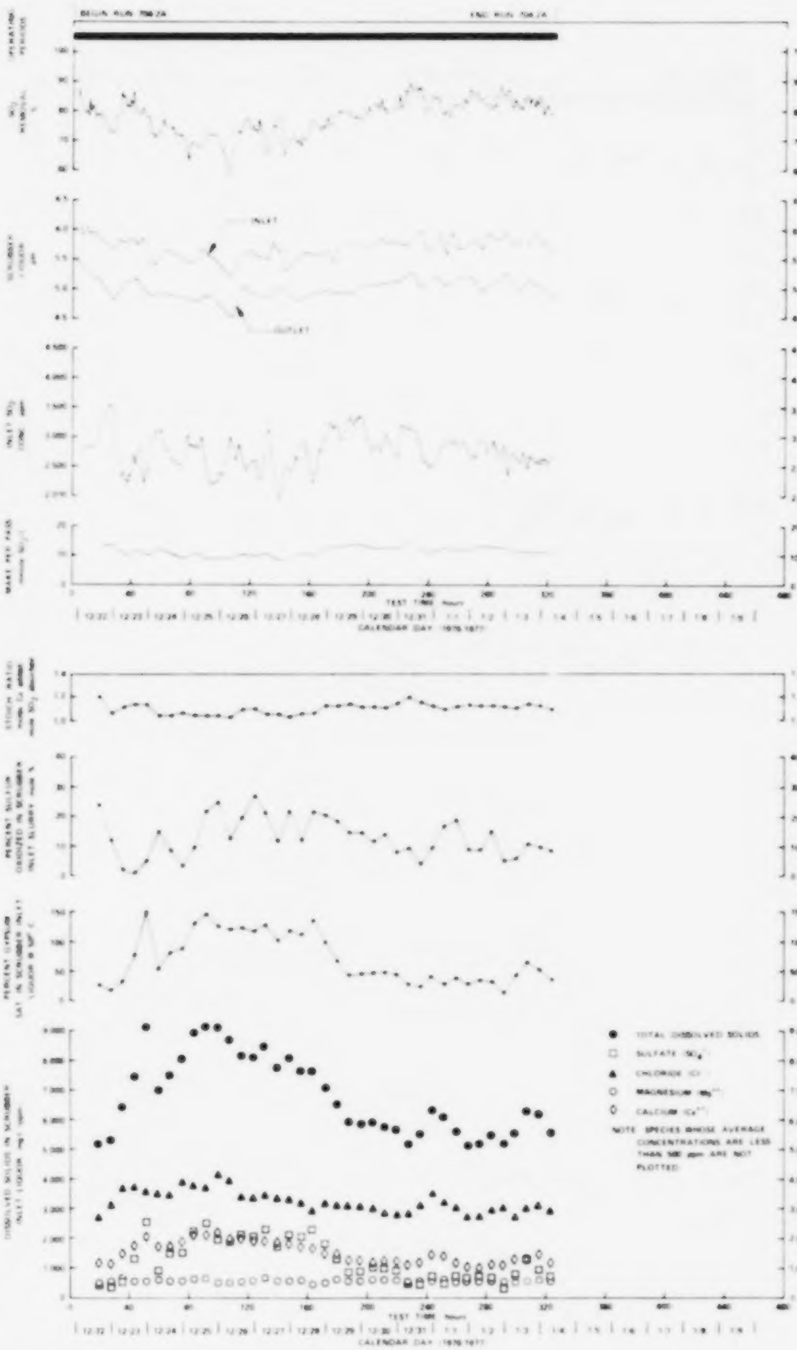
Figure I-14. OPERATING DATA FOR TCA RUN 702-2A



Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec
Liquor Rate = 1200 gpm
L/G = 50 gal/mcf
EHT Residence Time = 4.1 min
3 Beds, 4.3 in. spheres/bed

Percent Solids Recirculated = 7.5-8.2 wt %
Total Pressure Drop, Excluding Mist Elim.
= 6.9-7.9 in. H_2O
Mist Elim. Pressure Drop = 0.43-0.49 in. H_2O
Discharge (Clarifier & Centrifuge) Solids
Concentration = 41-55 wt %
Limestone Addition to EHT

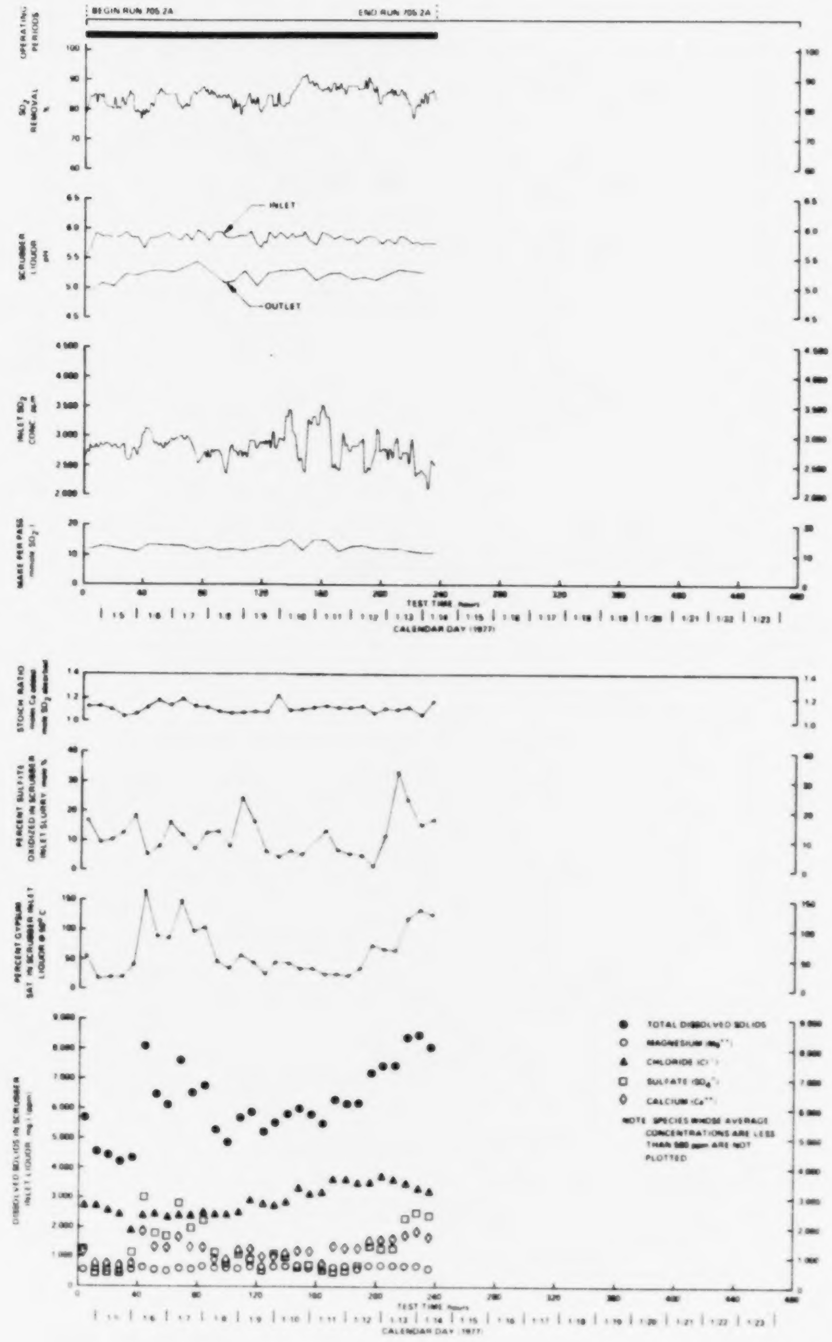
Figure I-15. OPERATING DATA FOR TCA RUN 703-2A



Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec
Liquor Rate = 1200 gpm
L/G = 50 gal/mcf
EHT Residence Time = 12 min (3 tanks)
3 Beds, 4 in. spheres/bed

Percent Solids Recirculated = 7.3-8.9 wt %
Total Pressure Drop, Excluding Mist Elim.
= 7.0-9.0 in. H_2O
Mist Elim. Pressure Drop = 0.40-0.54 in. H_2O
Discharge(Clarifier & Centrifuge) Solids
Concentration = 40-46 wt %
Limestone Addition to EHT

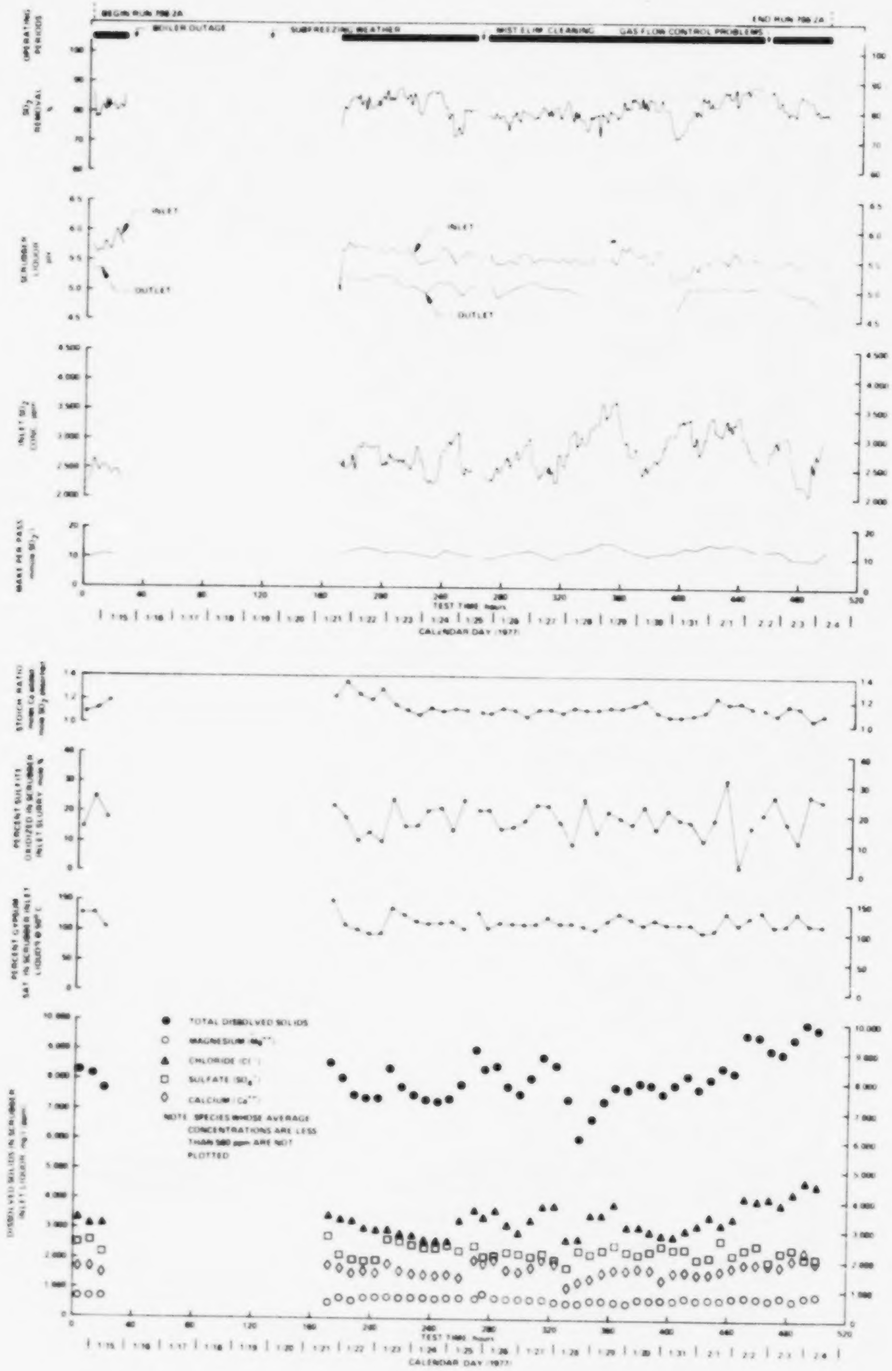
Figure I-16. OPERATING DATA FOR TCA RUN 704-2A



Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
EHT Residence Time = 12 min. (3 tanks)
3 Beds, 5.2 in. spheres/bed

Percent Solids Recirculated = 14.4-15.4 wt %
Total Pressure Drop, Excluding Mist Elim.
= 8.5-9.7 in. H_2O
Mist Elim. Pressure Drop = 0.43-0.52 in. H_2O
Discharge (Clarifier) Solids
Concentration = 32-40 wt %
Limestone Addition to First EHT

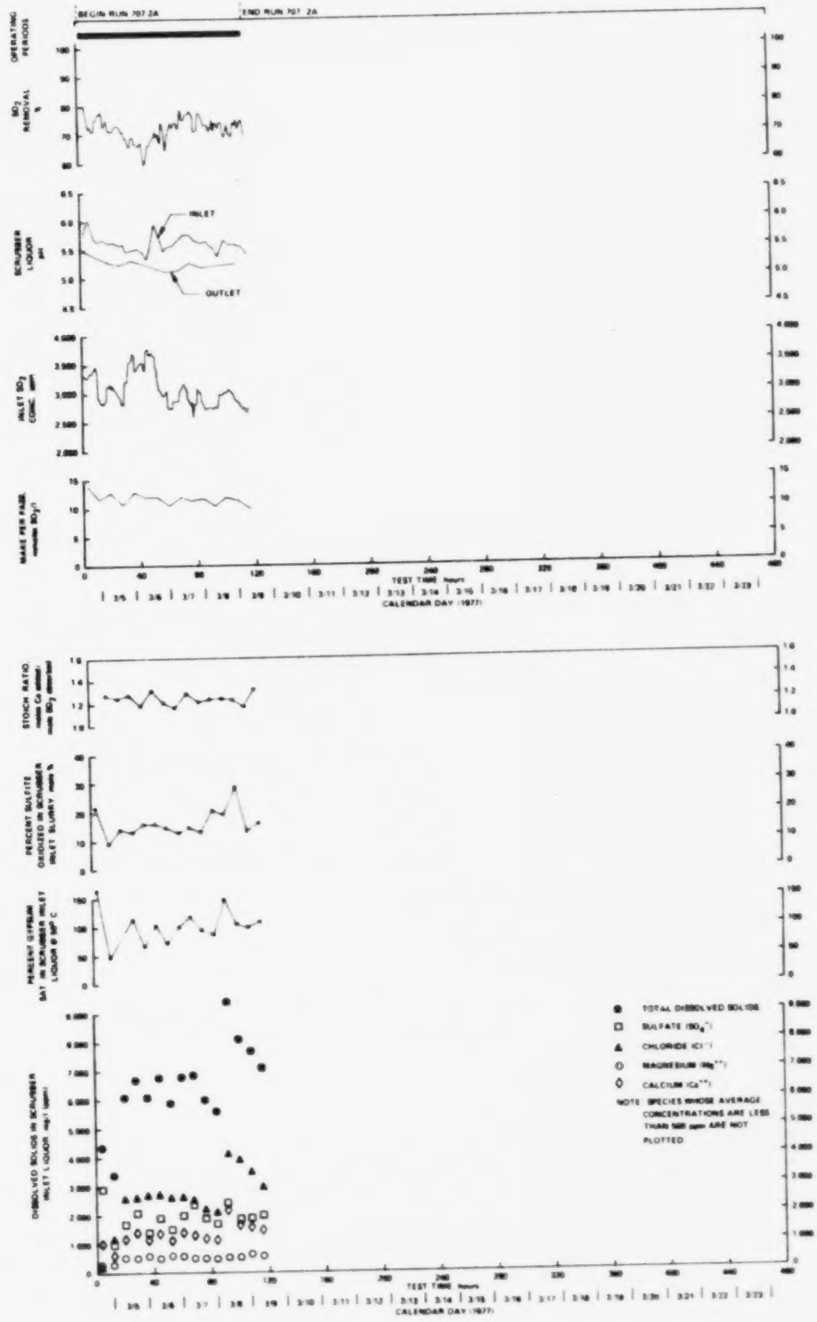
Figure I-17. OPERATING DATA FOR TCA RUN 705-2A



Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
EHT Residence Time = 12 min
3 Beds, 5 in. spheres/bed

Percent Solids Recirculated = 13.8-15.5 wt %
Total Pressure Drop, Excluding Mist Elim.
= 7.7-10.5 in. H_2O
Mist Elim. Pressure Drop = 0.44-0.59 in. H_2O
Discharge (Clarifier) Solids
Concentration = 31-41 wt %
Limestone Addition to EHT

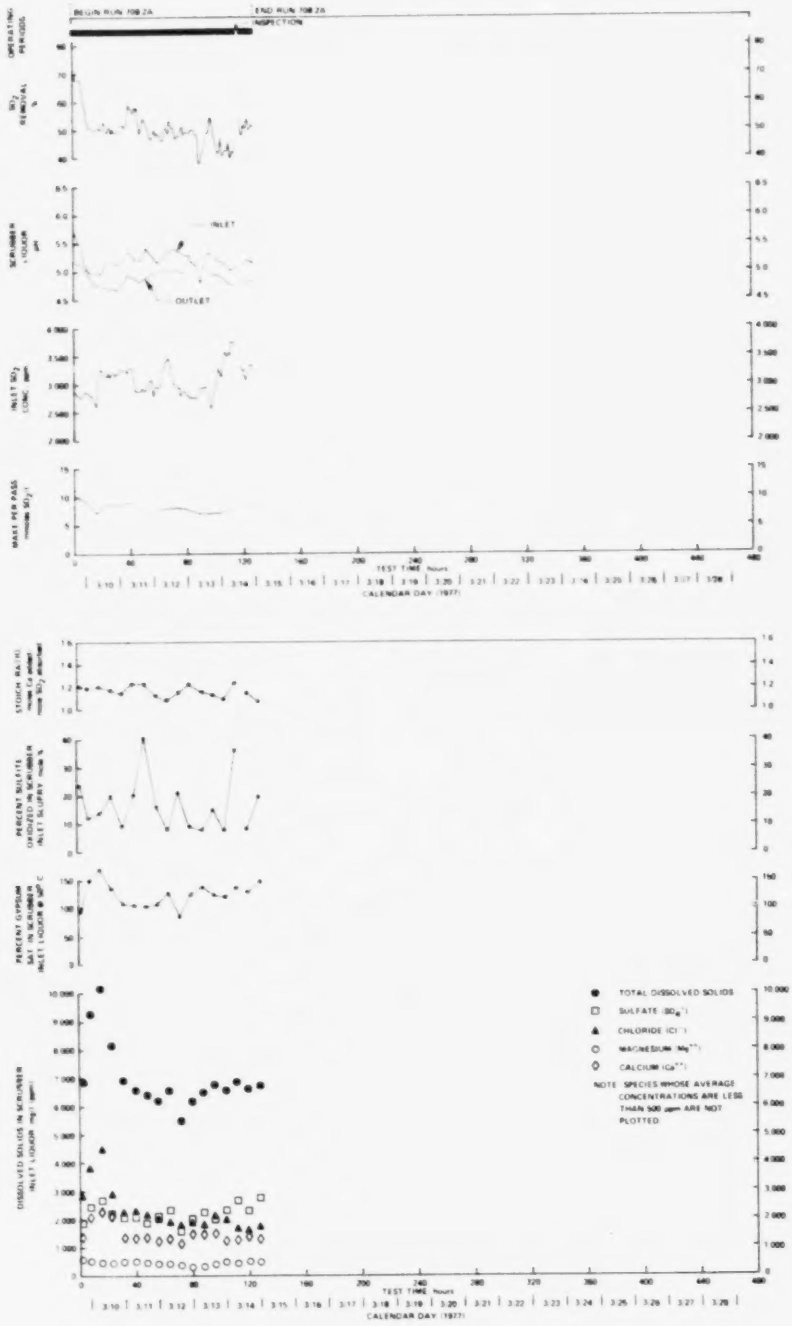
Figure I-18. OPERATING DATA FOR TCA RUN 706-2A



Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
EHT Residence Time = 4.1 min
3 Beds, 5 in. spheres/bed

Percent Solids Recirculated = 13.5-15.5 wt %
Total Pressure Drop, Excluding Mist Elim.
= 6.0-7.2 in. H_2O
Mist Elim. Pressure Drop = 0.45-0.57 in. H_2O
Discharge (Clarifier) Solids
Concentration = 38-42 wt %
Limestone Addition to EHT

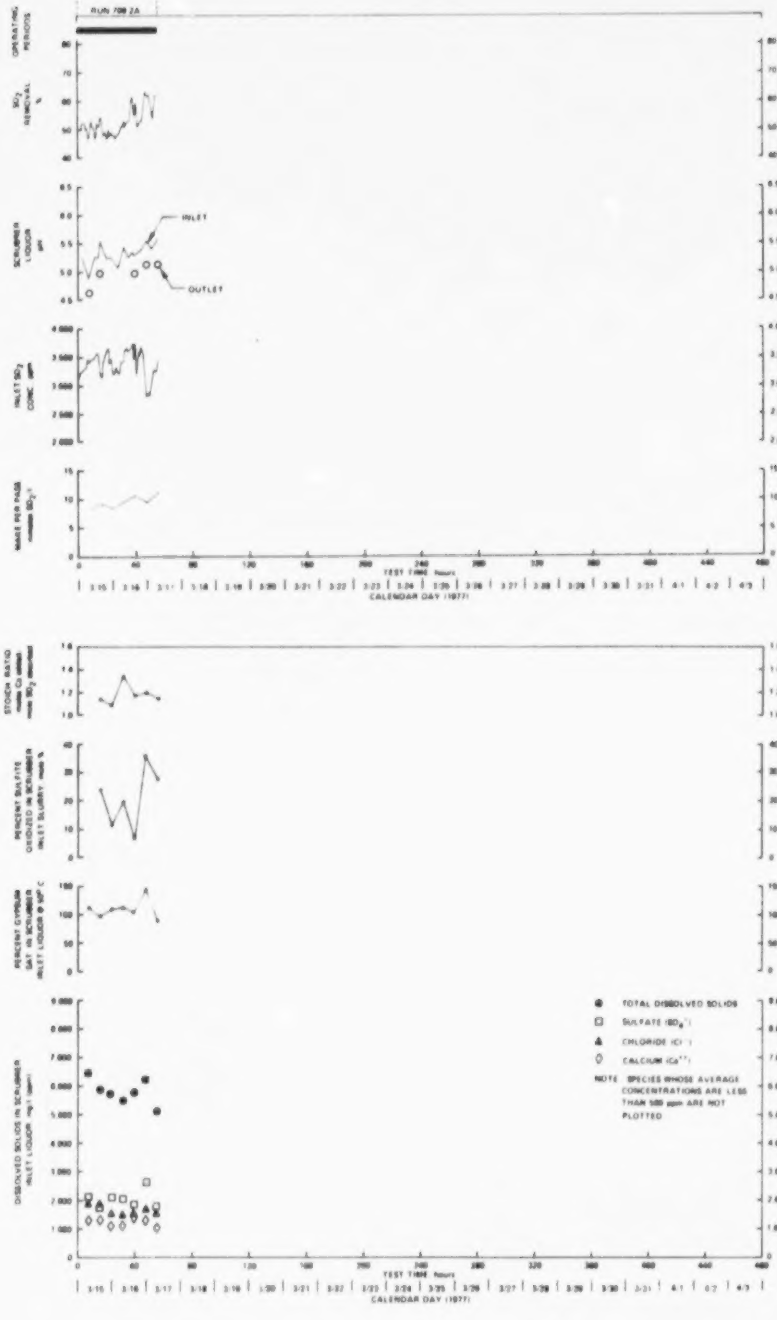
Figure I-19. OPERATING DATA FOR TCA RUN 707-2A



Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
EHT Residence Time = 4.1 min
3 Beds, 5 in. spheres/bed

Percent Solids Recirculated = 14.6-15.9 wt %
Total Pressure Drop, Excluding Mist Elim.
= 5.8-8.2 in. H_2O
Mist Elim. Pressure Drop = 0.44-0.49 in. H_2O
Discharge (Clarifier) Solids
Concentration = 37-43 wt %
Limestone Addition to EHT

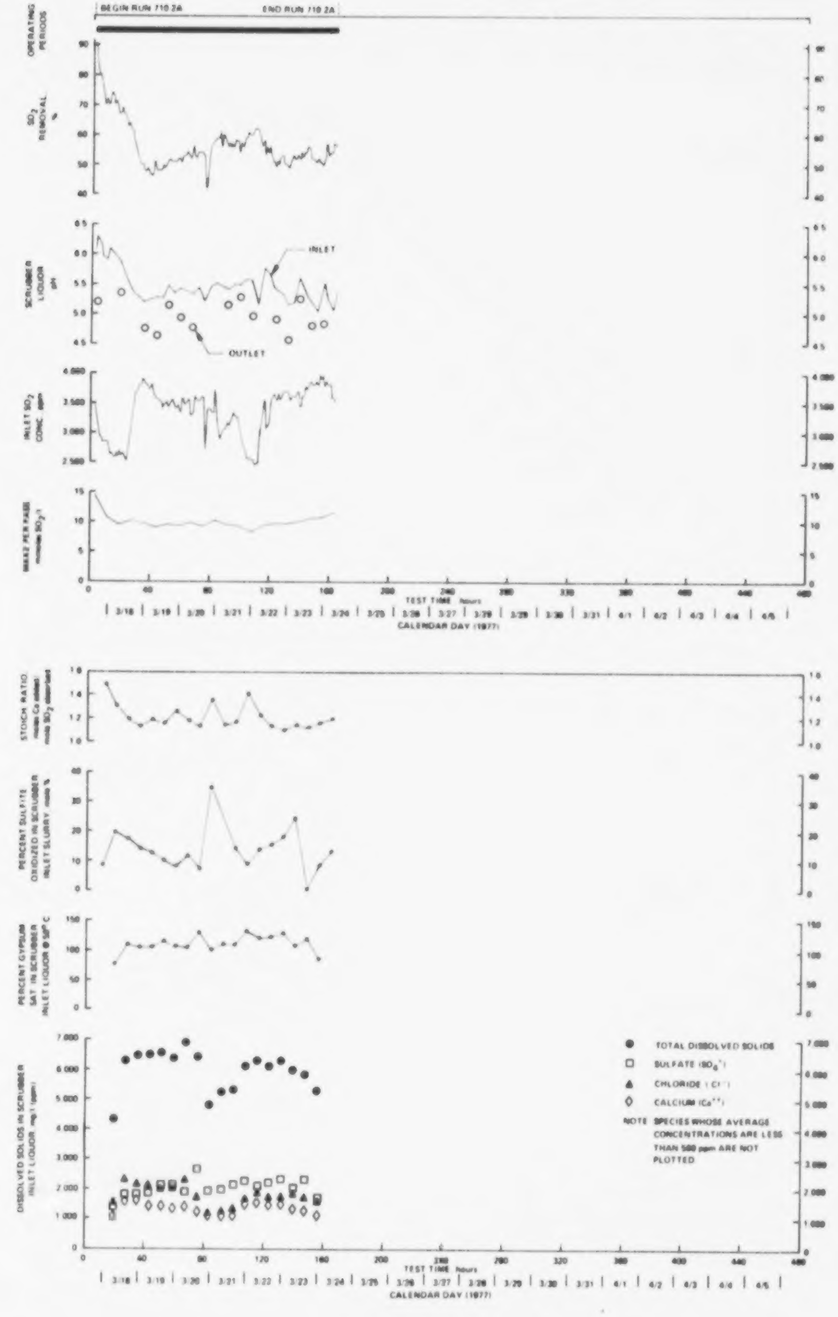
Figure I-20. OPERATING DATA FOR TCA RUN 708-2A



Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
EHT Residence Time = 4.1 min
3 Beds, 5 in. spheres/bed

Percent Solids Recirculated = 13.1-14.9 wt %
Total Pressure Drop, Excluding Mist Elim.
= 6.0-6.7 in. H_2O
Mist Elim. Pressure Drop = 0.44-0.48 in. H_2O
Discharge (Clarifier) Solids
Concentration = 37-41 wt %
Limestone Addition to EHT

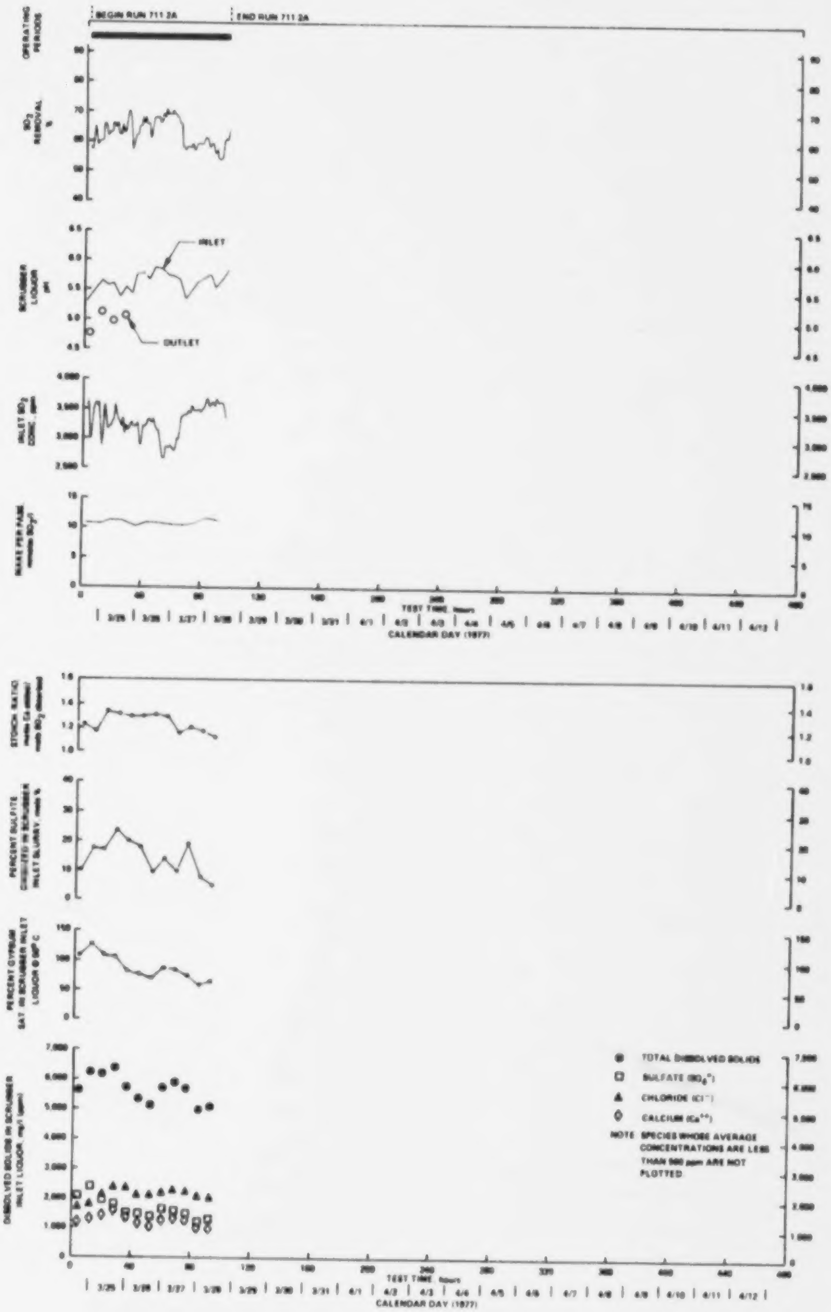
Figure I-21. OPERATING DATA FOR TCA RUN 709-2A



Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
EHT Residence Time = 12 min
3 Beds, 5 in. spheres/bed

Percent Solids Recirculated = 14.3-15.1 wt %
Total Pressure Drop, Excluding Mist Elim.
= 6.0-6.7 in. H_2O
Mist Elim. Pressure Drop = 0.47-0.55 in. H_2O
Discharge (Clarifier) Solids
Concentration = 38-48 wt %
Limestone Addition to EHT

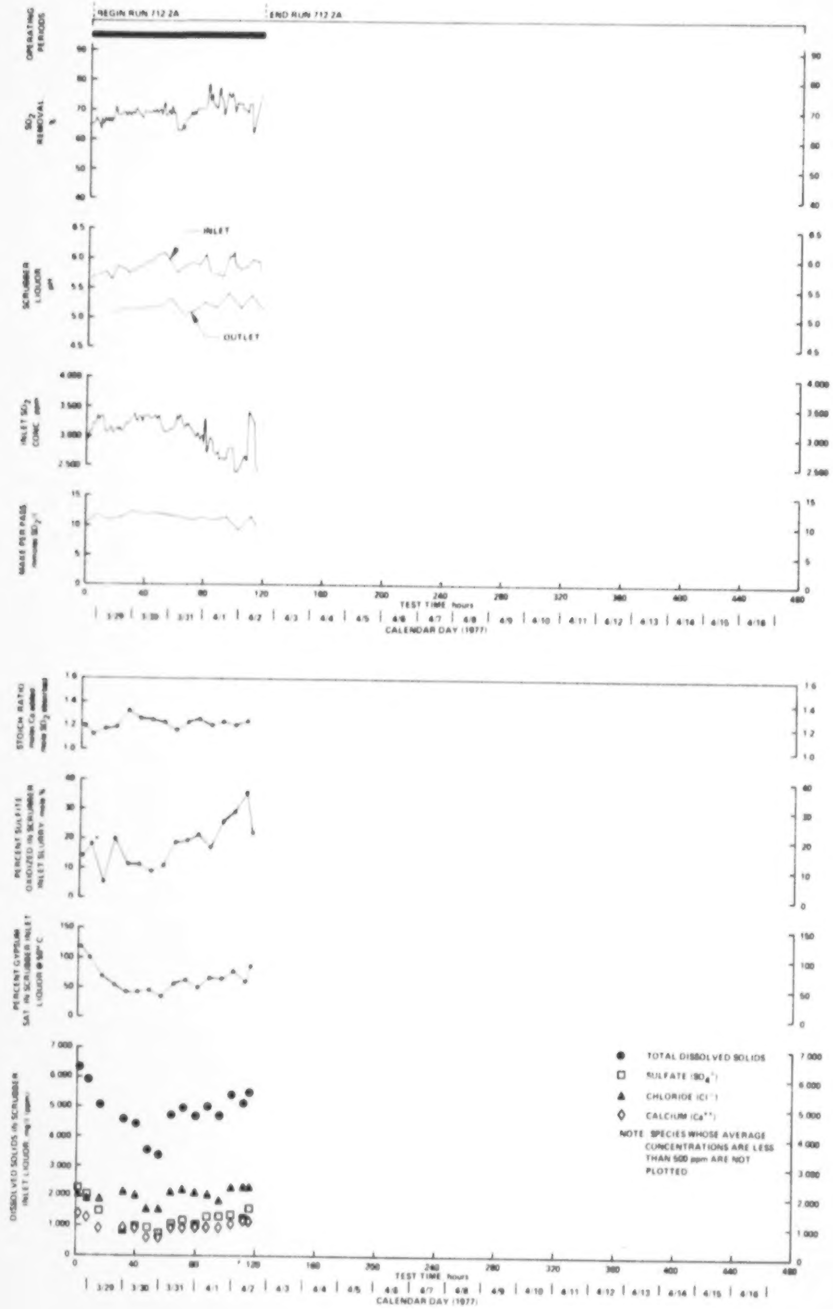
Figure I-22. OPERATING DATA FOR TCA RUN 710-2A



Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
EHT Residence Time = 12 min
3 Beds, 5 in. spheres/bed

Percent Solids Recirculated = 13.5-15.1 wt %
Total Pressure Drop, Excluding Mist Elim.
= 6.3-6.8 in. H_2O
Mist Elim. Pressure Drop = 0.50-0.62 in. H_2O
Discharge (Clarifier) Solids
Concentration = 35-40 wt %
Limestone Addition to EHT

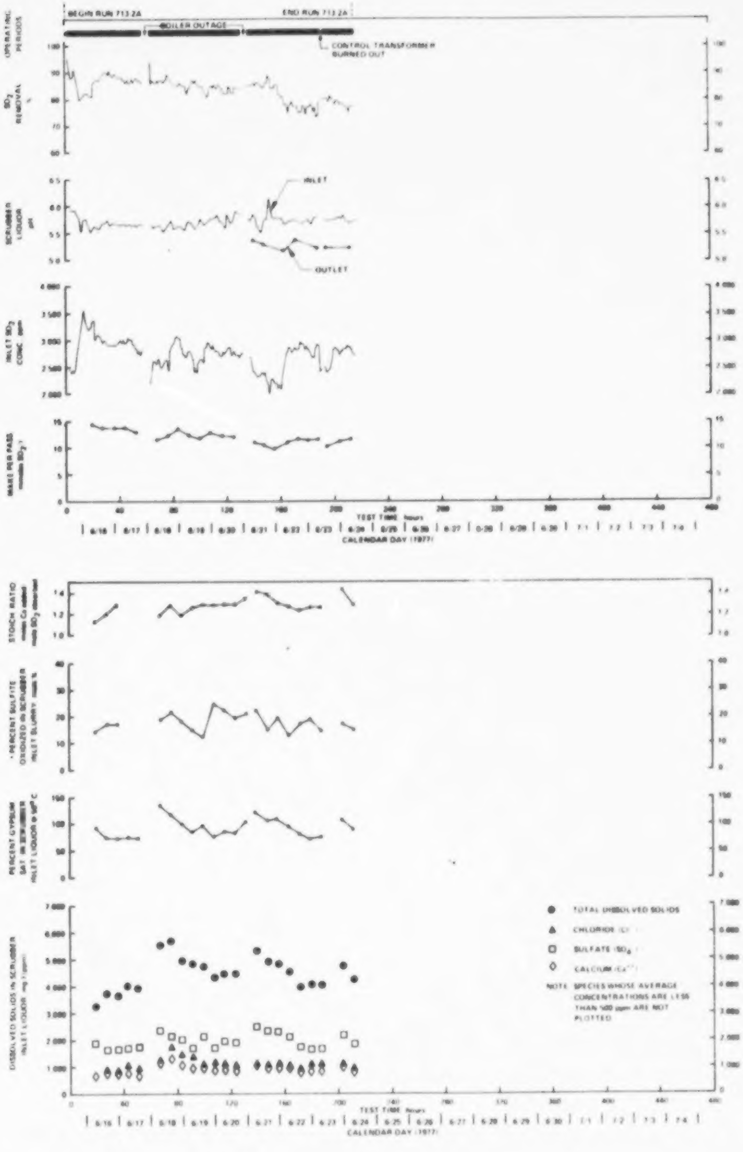
Figure I-23. OPERATING DATA FOR TCA RUN 711-2A



Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
EHT Residence Time = 12 min (3 tanks)
3 Beds, 5 in. spheres/bed

Percent Solids Recirculated = 13-16 wt %
Total Pressure Drop, Excluding Mist Elim.
= 6.2-7.2 in. H_2O
Mist Elim. Pressure Drop = 0.48-0.61 in. H_2O
Discharge (Clarifier) Solids
Concentration = 36-43 wt %
Limestone Addition to First EHT

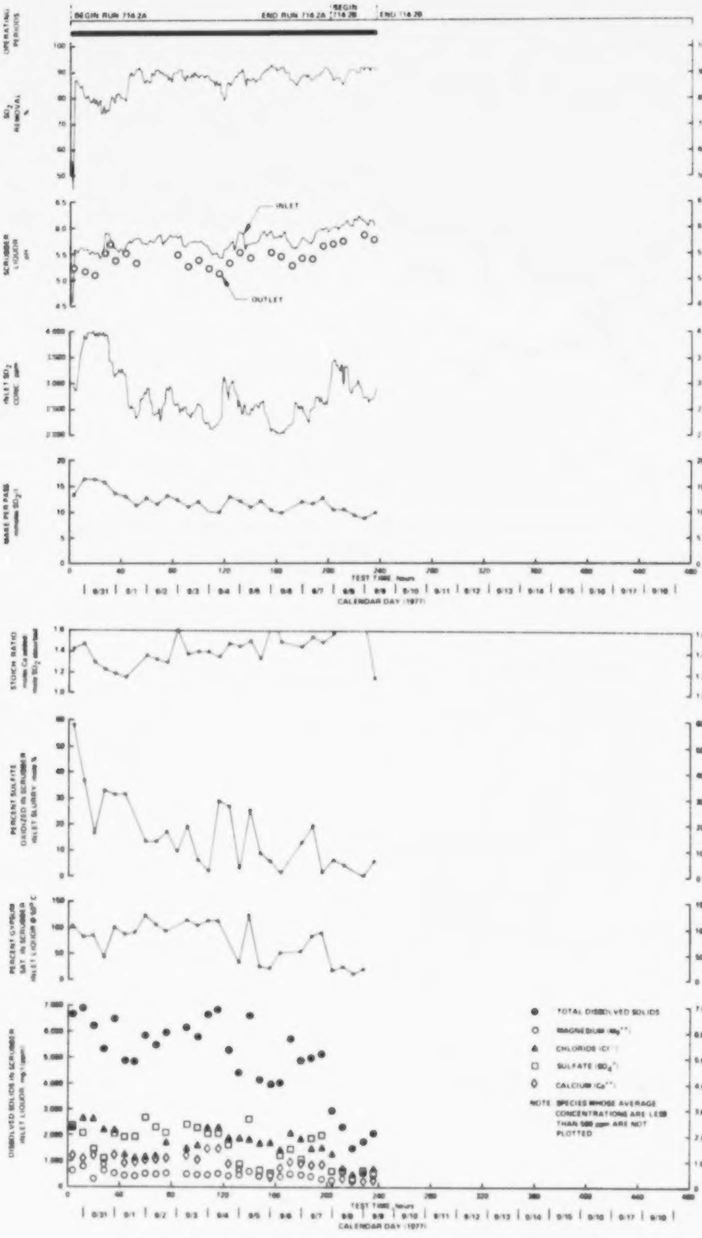
Figure I-24. OPERATING DATA FOR TCA RUN 712-2A



Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
EHT Residence Time = 12 min
3 Beds, 5 in. spheres/bed

Percent Solids Recirculated = 14.1-15.7 wt %
Total Pressure Drop, Excluding Mist Elim.
= 7.0-9.4 in. H_2O
Mist Elim. Pressure Drop = 0.44-0.50 in. H_2O
Discharge (Clarifier) Solids
Concentration = 38-42 wt %
Limestone Addition to EHT
By Automatic Control

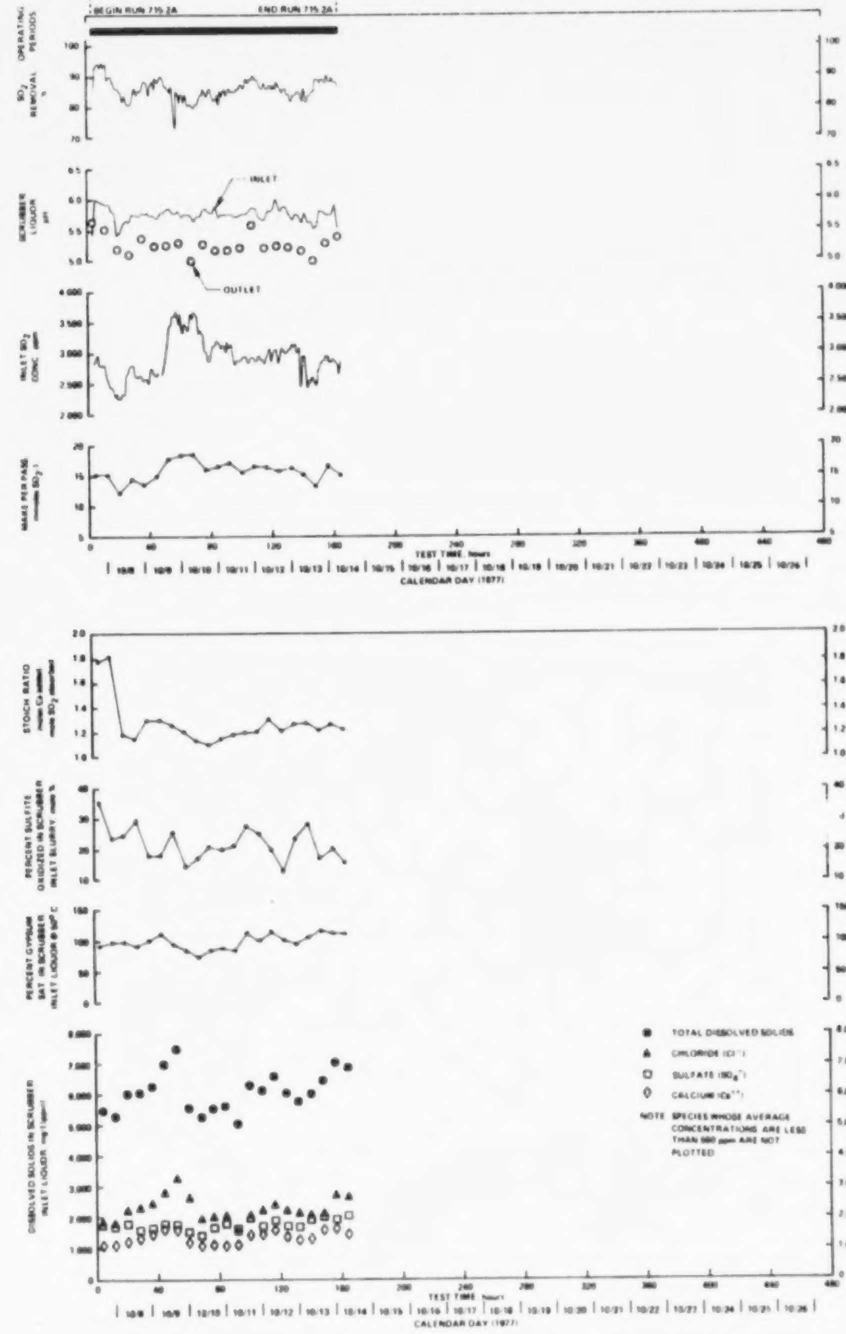
Figure I-25. OPERATING DATA FOR TCA RUN 713-2A



Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
3 Beds, 5 in. spheres/bed

Percent Solids Recirculated = 14.1-16.3 wt %
Total Pressure Drop, Excluding Mist Elim.
= 7.7-9.8 in H_2O
Mist Elim. Pressure Drop = 0.33-0.46 in. H_2O
Discharge (Clarifier) Solids
Concentration = 32-40 wt %
Limestone Addition to EHT
By Automatic Control

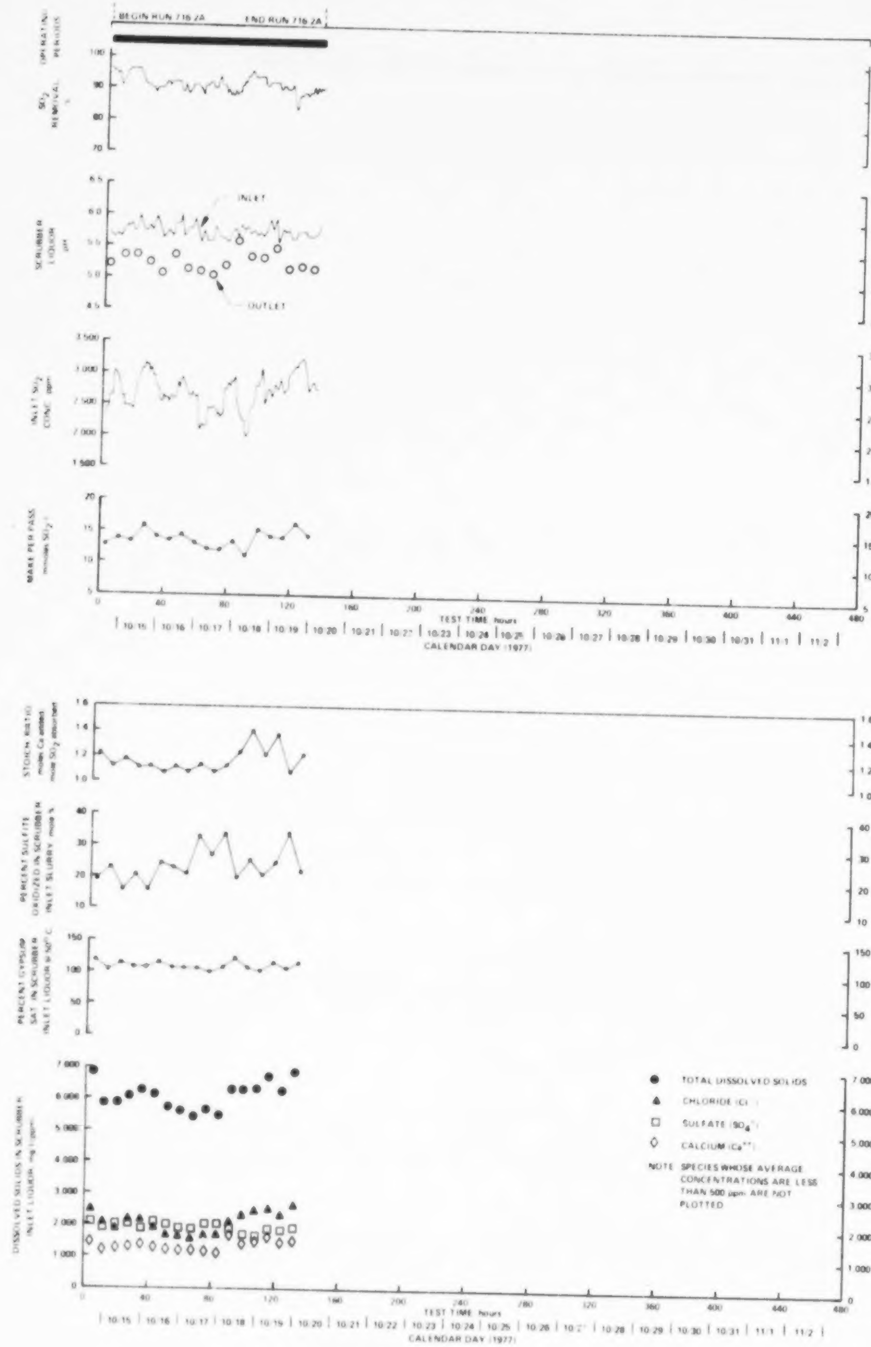
Figure I-26. OPERATING DATA FOR TCA RUN 714-2A



Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec
Liquor Rate = 1000 gpm
L/G = 42 gal/Mcf
EHT Residence Time = 14.4 min (3 Tanks)
3 Beds, 7.5 in. spheres/bed

Percent Solids Recirculated = 14.4-15.6 wt %
Total Pressure Drop, Excluding Mist Elim
= 10.0-12.5 in. H_2O
Mist Elim. Pressure Drop = 0.44-0.56 in. H_2O
Discharge (Clarifier) Solids
Concentration = 30-42 wt %
Limestone Addition to First Hold Tank

Figure I-27. OPERATING DATA FOR TCA RUN 715-2A



Gas Rate = 27,000 acfm @ 300° F
Gas Velocity = 11.3 ft/sec
Liquor Rate = 1000 gpm
L/G = 46 gal/Mcf
EHT Residence Time = 14.4 min (3 Tanks)
3 Beds, 10 in. spheres/bed

Percent Solids Recirculated = 13.8-15.1 wt %
Total Pressure Drop, Excluding Mist Elim.
= 12.8-16.1 in. H_2O
Mist Elim. Pressure Drop = 0.34-0.44 in. H_2O
Discharge (Clarifier) Solids
Concentration = 33-41 wt %
Limestone Addition to First Hold Tank

Figure I-28. OPERATING DATA FOR TCA RUN 716-2A

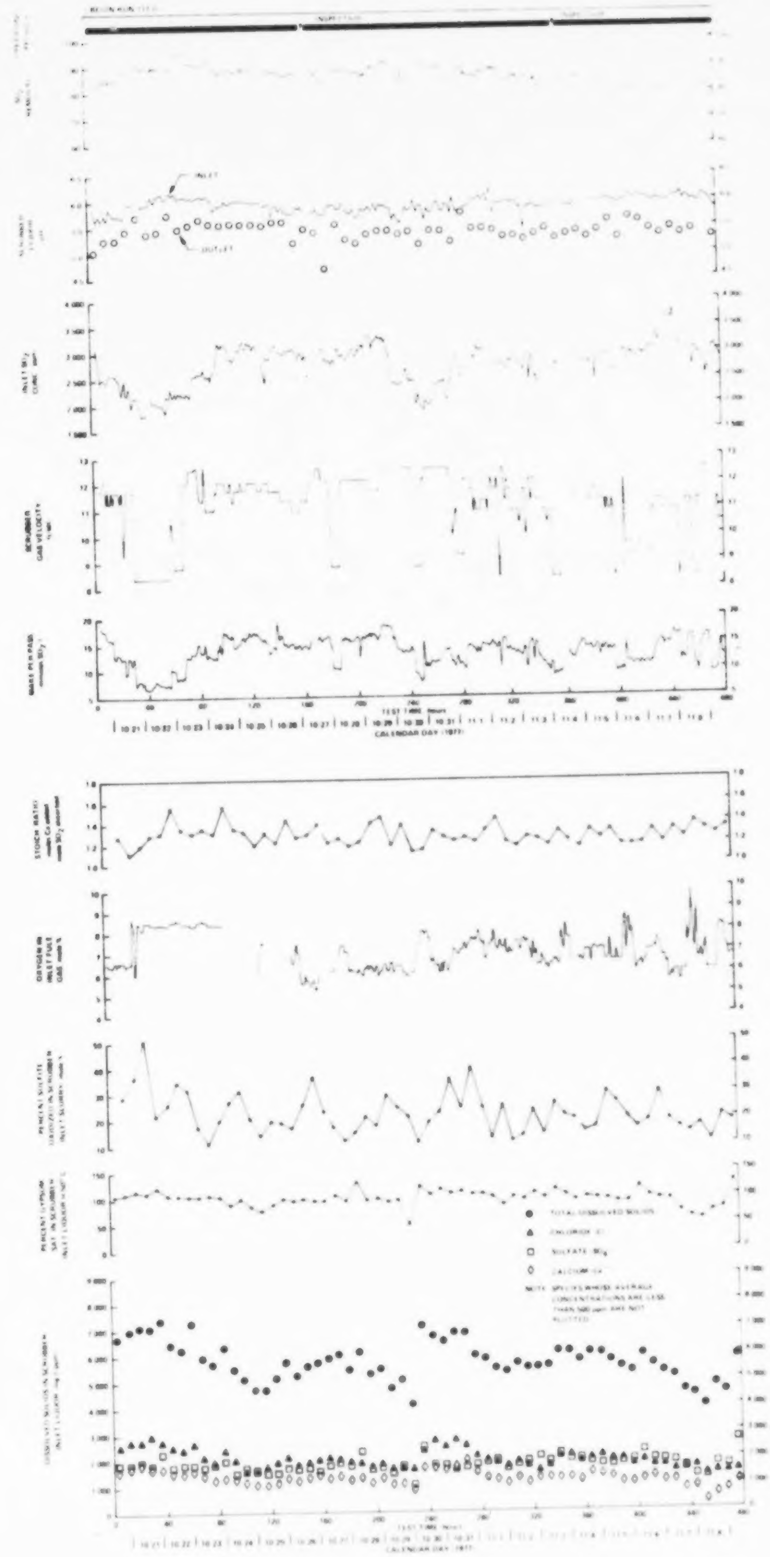
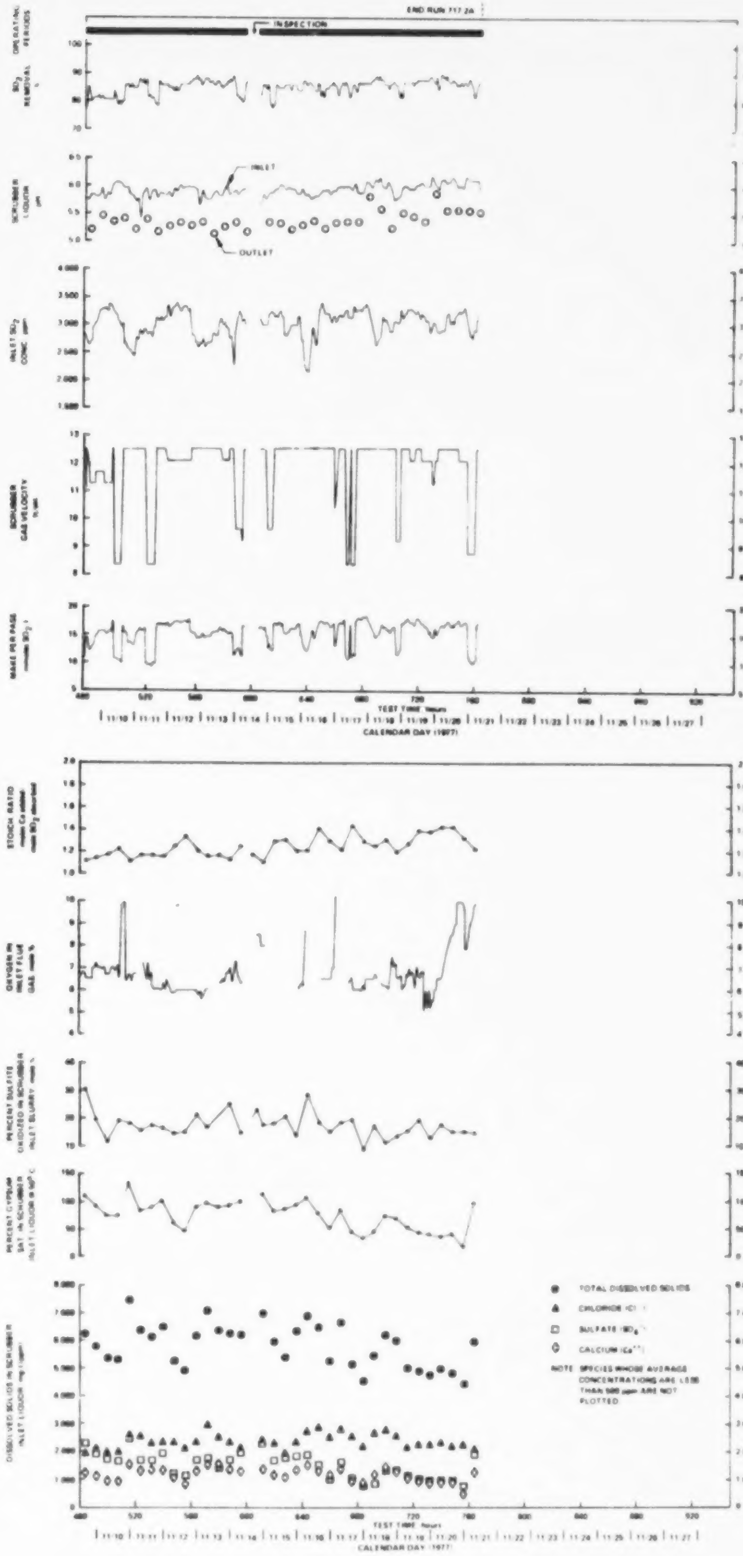
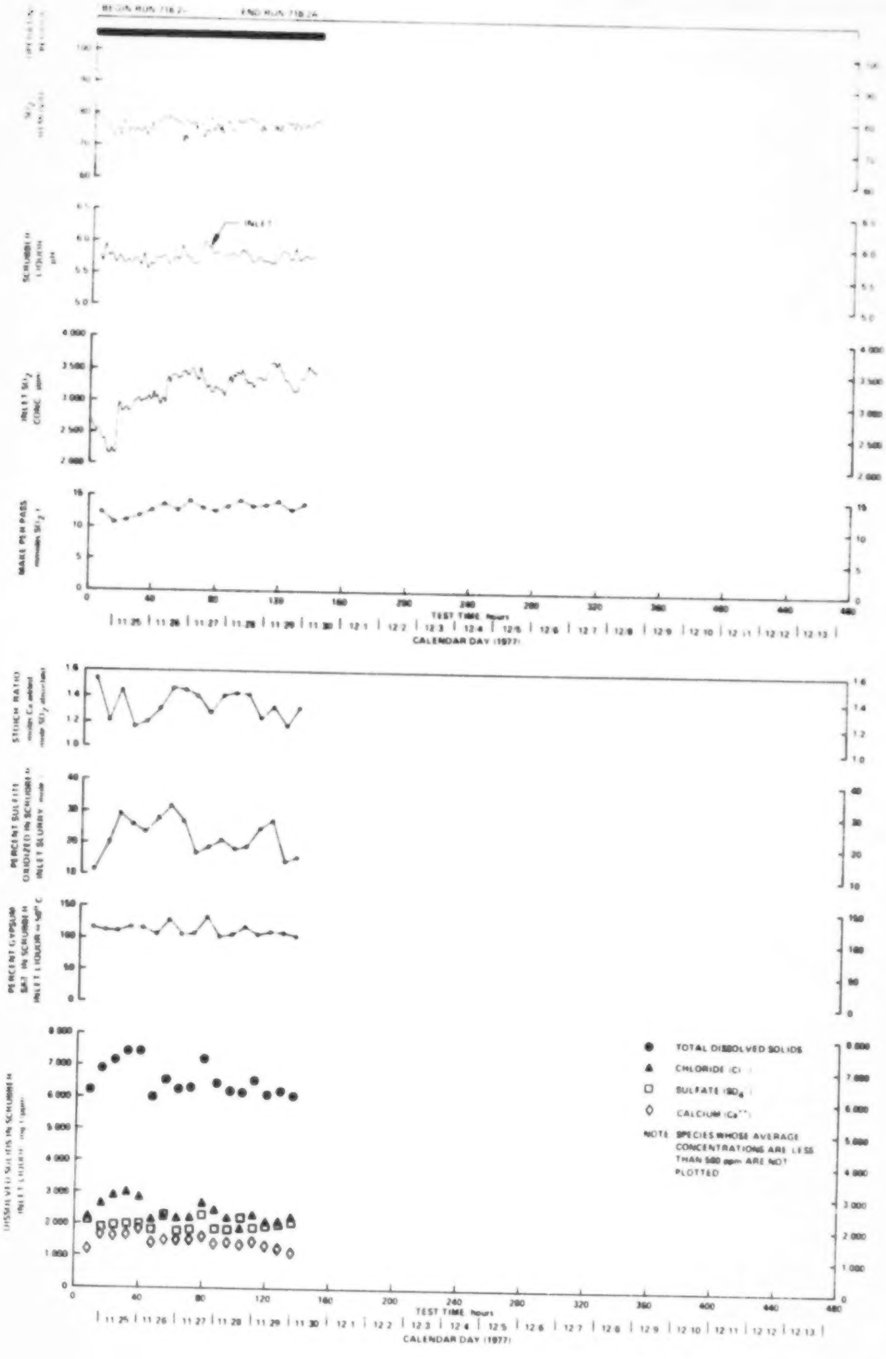


Figure I-29. OPERATING DATA FOR TCA RUN 717-2A



Gas Rate - 20,000-30,000 acfm @ 300° F
Gas Velocity - 8.4-12.5 ft/sec
Liquor Rate - 1000 gpm
L/G - 42-62 gal/Mcf
EHT Residence Time - 14.4 min (3 Tanks)
3 Beds, 7.5 in. spheres/bed
Percent Solids Recirculated - 13.7-15.7 wt %
Total Pressure Drop, Excluding Mist Elim.
- 5.8-13.4 in. H_2O
Mist Elim. Pressure Drop - 0.17-0.52 in. H_2O
Discharge (Clarifier) Solids
Concentration - 31-45 wt %
Limestone Addition to First Hold Tank

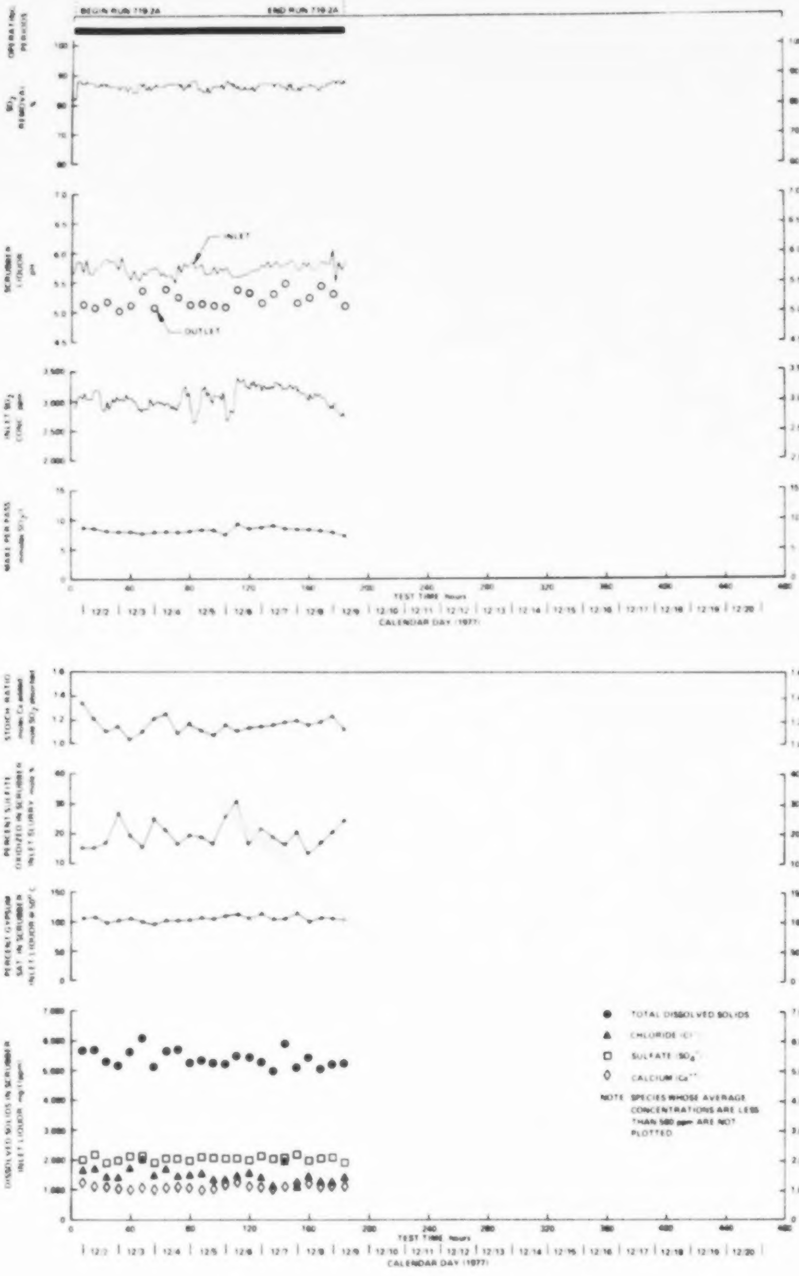
Figure I-29 (continued). OPERATING DATA FOR TCA RUN 717-2A



Gas Rate = 30,000 acfm @ 300 °F
Gas Velocity = 12.5 ft/sec
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
EHT Residence Time = 12 min
4 Grids with 23 Layers (46 in. High) of
Ceilcote Plates Between 2 nd & 3 rd Grid

Percent Solids Recirculated = 13.6-15.1 wt %
Total Pressure Drop, Excluding Mist Elim.
= 6.5-8.7 in. H_2O
Mist Elim. Pressure Drop = 0.40-0.50 in. H_2O
Discharge (Clarifier) Solids
Concentration = 36-40 wt %
Limestone Addition to EHT

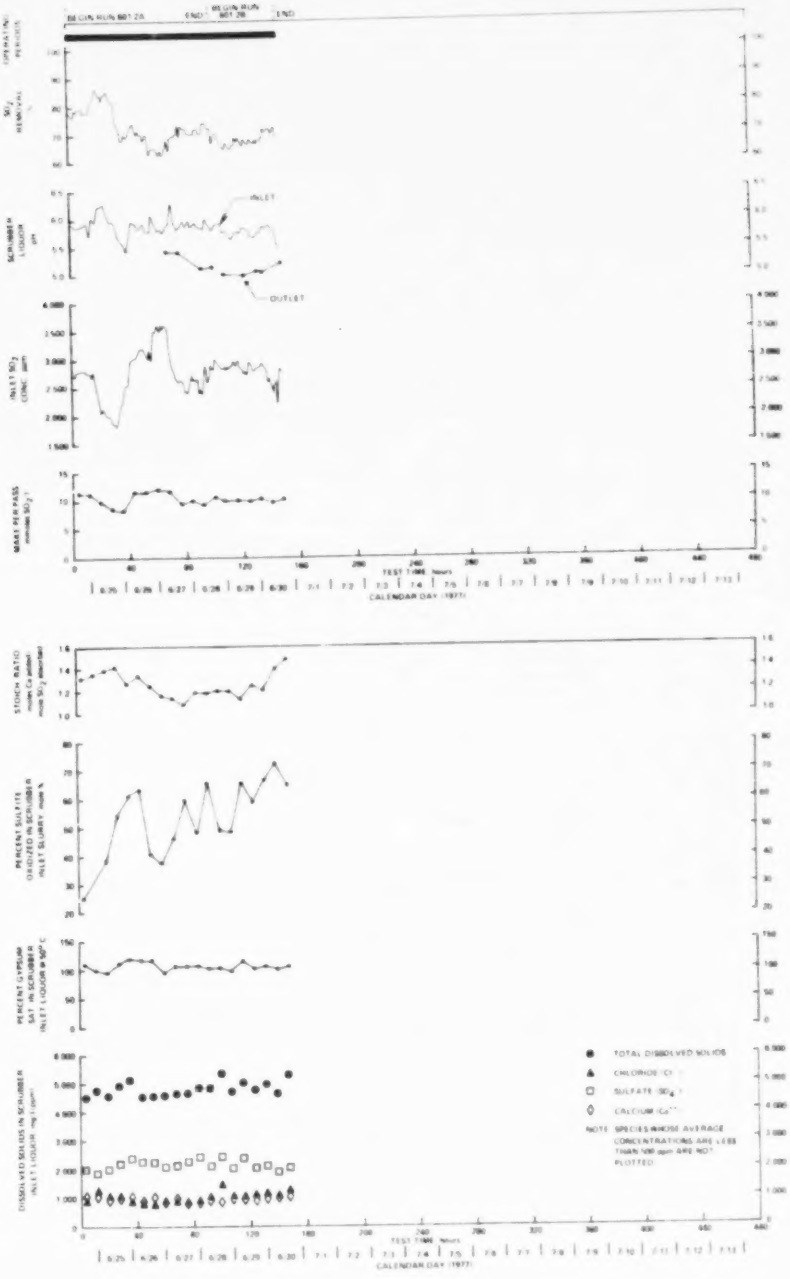
Figure I-30. OPERATING DATA FOR TCA RUN 718-2A



Gas Rate = 18,000 acfm @ 300° F
Gas Velocity = 7.5 ft/sec
Liquor Rate = 1200 gpm
L/G = 83 gal/Mcf
EHT Residence Time = 12 min
4 Grids with 23 Layers (46 in. High) of
Ceilcote Plates Between 2nd & 3rd Grid

Percent Solids Recirculated = 14.1-15.5 wt %
Total Pressure Drop, Excluding Mist Elim.
= 2.6-4.0 in. H_2O
Mist Elim. Pressure Drop = 0.13-0.20 in. H_2O
Discharge (Clarifier) Solids
Concentration = 35-41 wt %
Limestone Addition to EHT

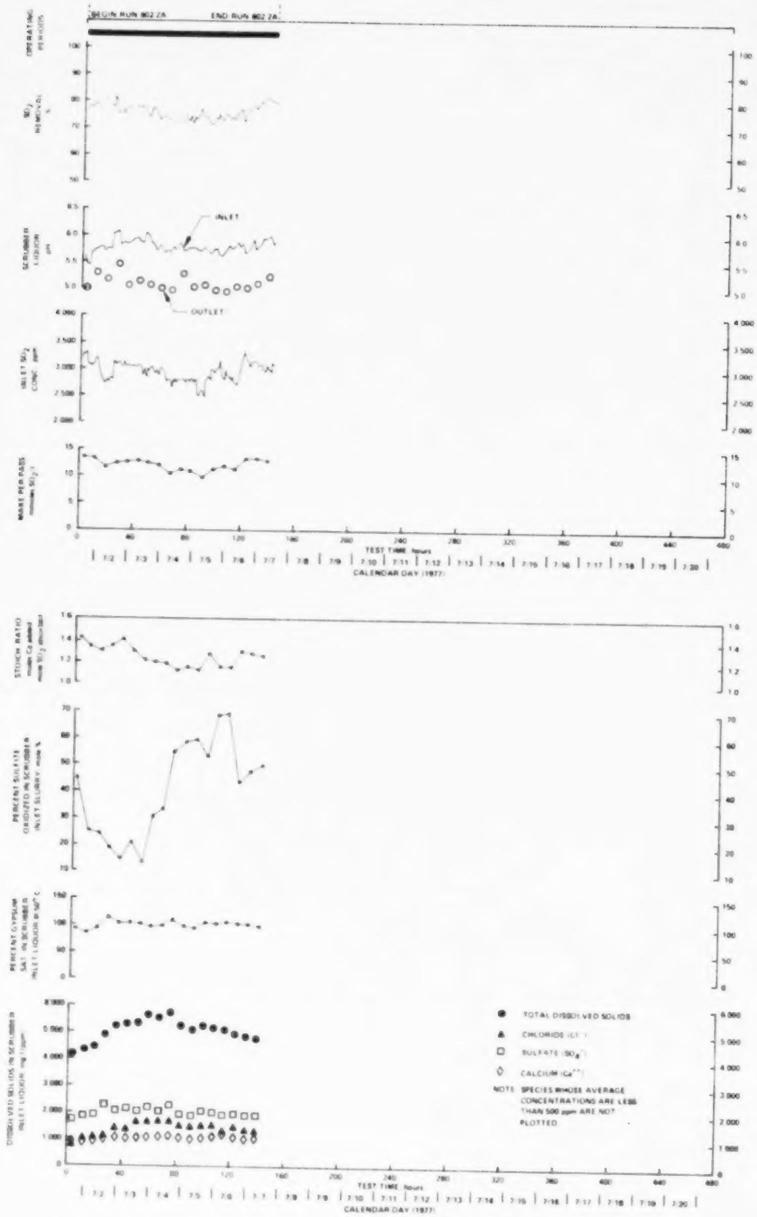
Figure I-31. OPERATING DATA FOR TCA RUN 719-2A



Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
EHT Residence Time = 12 min (801-2A)
= 15.7 min (801-2B)
EHT Level = 6.1 ft(801-2A)
= 8.0 ft (801-2B)
3 Beds, 5 in. spheres/bed
Air Flow Rate to Oxidizer = 600 (Est.) scfm (801-2A)
= 530 scfm (801-2B)
Liquor Flow Rate to Oxidizer = 1500 gpm
Air Eductor Discharged At 6 ft From Bottom of EHT

Percent Solids Recirculated = 13.8-15.4 wt %
Total Pressure Drop, Excluding Mist Elim.
= 6.7-7.5 in. H_2O
Mist Elim. Pressure Drop = 0.47-0.51 in. H_2O
Limestone Addition to EHT
Discharge (Clarifier) Solids
Concentration = 34-45 wt %

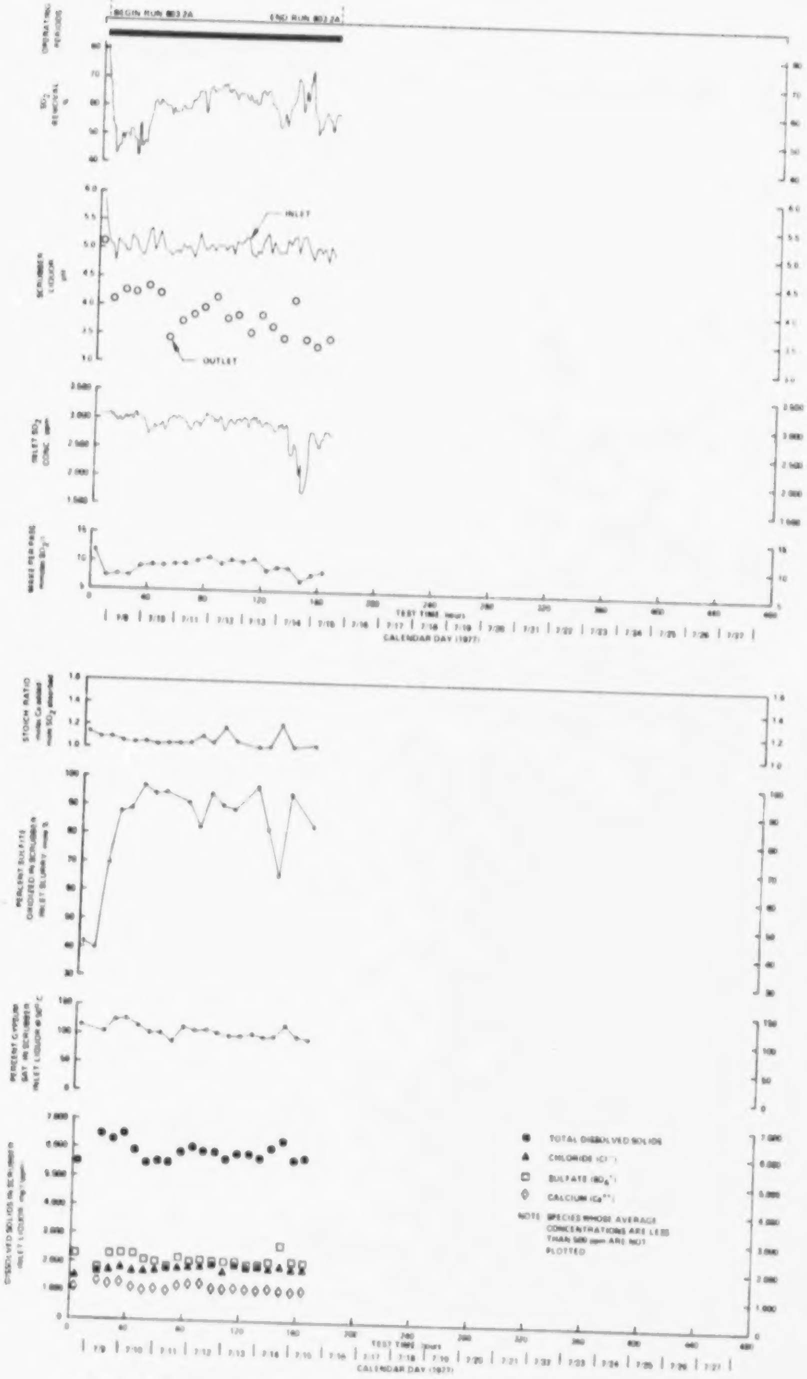
Figure I-32. OPERATING DATA FOR TCA RUNS 801-2A AND 801-2B



Gas Rate = 30,000 acfm @ 300 °F
Gas Velocity = 12.5 ft/sec
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
3 Beds, 5 in. spheres/bed
Percent Solids Recirculated = 14.7-15.9 wt %
Limestone Addition to EHT
Discharge (Clarifier) Solids
Concentration = 32-38 wt %

Total Pressure Drop, Excluding Mist Elim.
= 7.9-9.0 in. H_2O
Mist Elim. Pressure Drop = 0.47-0.56 in. H_2O
Air Flow Rate to Oxidizer = 485 acfm
Liquor Flow Rate to Oxidizer = 1000 gpm
Air Eductor Discharged At 10 ft From Bottom of EHT
EHT Residence Time = 23.5 min
EHT Level = 12 ft

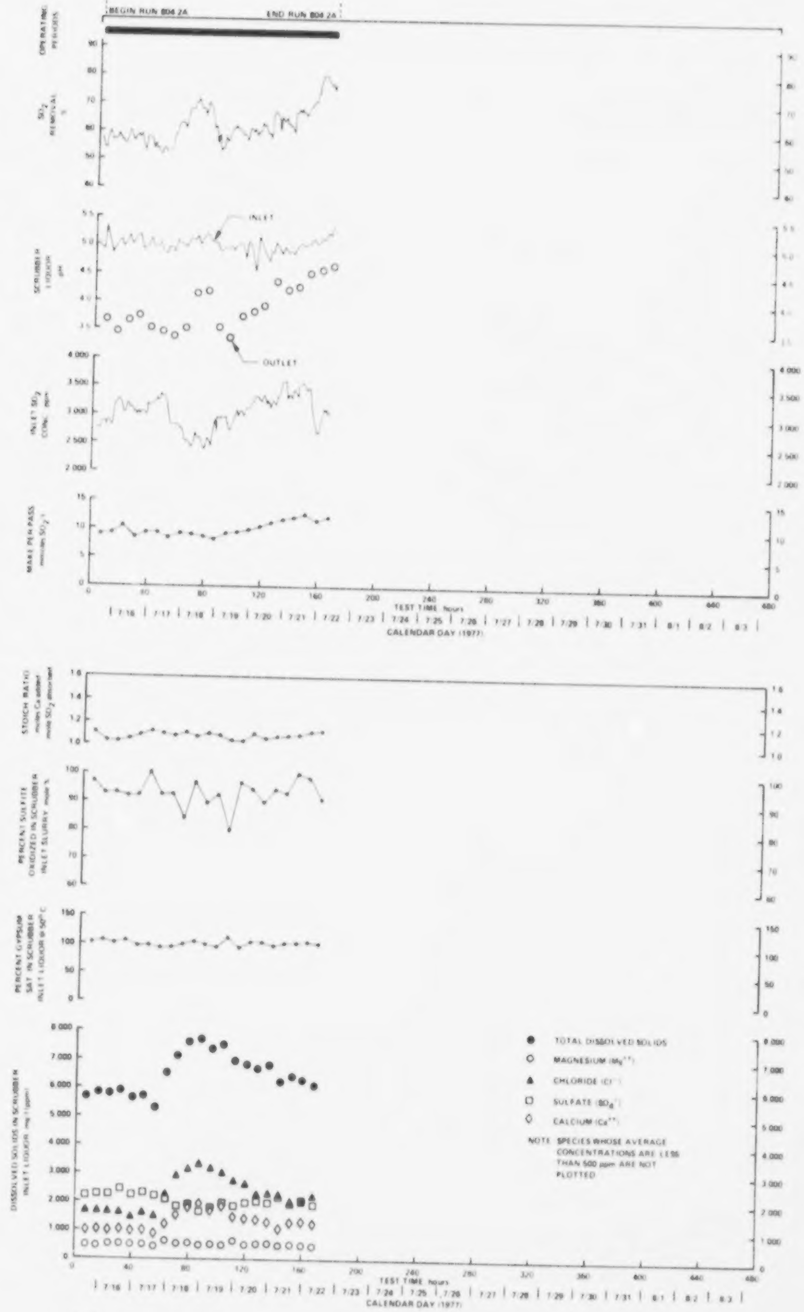
Figure I-33. OPERATING DATA FOR TCA RUN 802-2A



Gas Rate = 30,000 acfm @ 300 °F
Gas Velocity = 12.5 ft/sec
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
3 Beds, 5 in. spheres/bed
Percent Solids Recirculated = 14.1-15.7 wt %
Limestone Addition to EHT
Discharge (Clarifier) Solids
Concentration = 33-48 wt %

Total Pressure Drop, Excluding Mist Elim.
= 7.9-8.9 in. H_2O
Mist Elim. Pressure Drop = 0.40-0.52 in. H_2O
Air Flow Rate to Oxidizer = 486 acfm
Liquor Flow Rate to Oxidizer = 1600 gpm
Air Eductor Discharged At 10 ft From Bottom of EHT
EHT Residence Time = 23.5 min
EHT Level = 12 ft

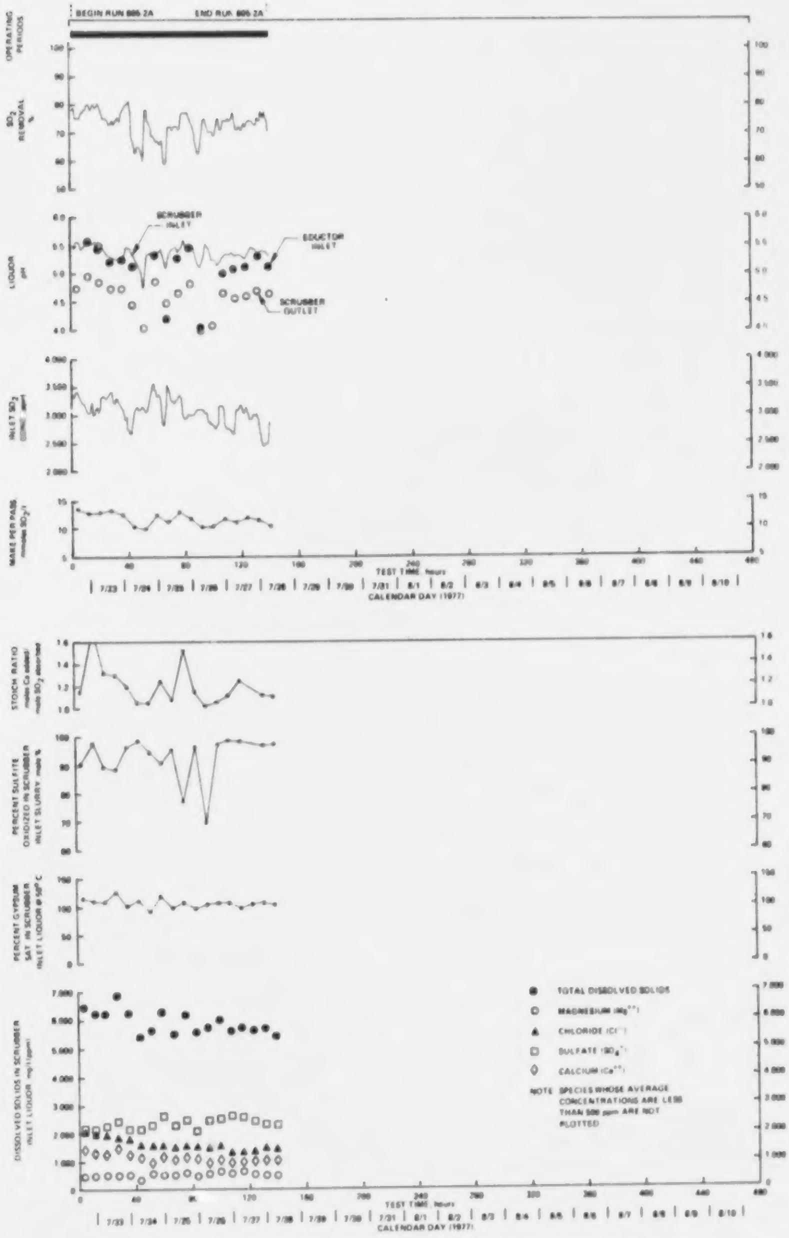
Figure I-34. OPERATING DATA FOR TCA RUN 803-2A



Gas Rate = 30,000 acfm @ 300°F
Gas Velocity = 12.5 ft/sec
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
3 Beds, 5 in. spheres/bed
Percent Solids Recirculated = 14.0-16.0 wt %
Limestone Addition to EHT
Discharge (Clarifier) Solids
Concentration = 30-50 wt %

Total Pressure Drop, Excluding Mist Elim.
= 7.8-8.8 in. H_2O
Mist Elim. Pressure Drop = 0.40-0.46 in. H_2O
Air Flow Rate to Oxidizer = 410 scfm
Liquor Flow Rate to Oxidizer = ~1600 gpm
Air Eductor Discharged At 10 ft From Bottom of EHT
EHT Residence time = 23.5 min
EHT Level = 12 ft

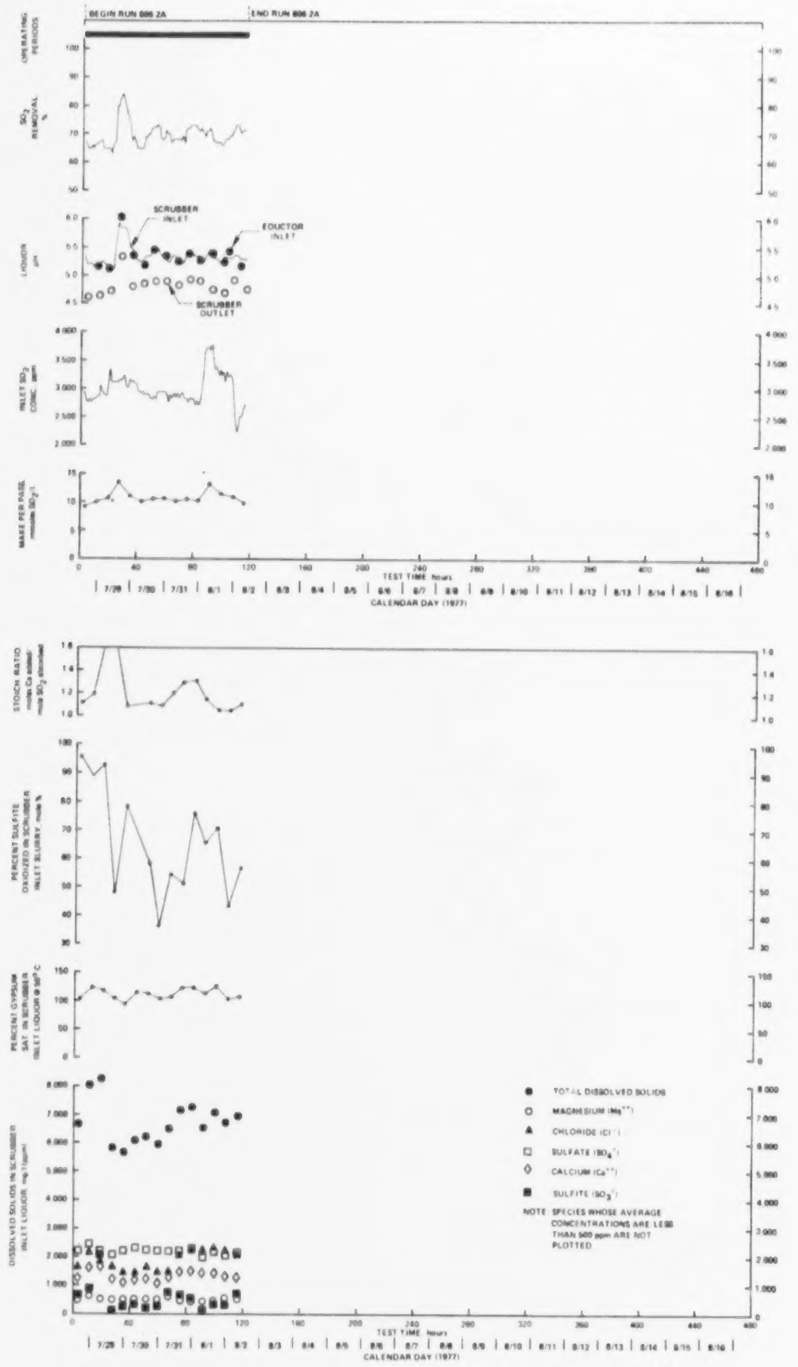
Figure I-35. OPERATING DATA FOR TCA RUN 804-2A



Gas Rate = 30,000 acfm @ 300 °F
Gas Velocity = 12.5 ft/sec
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
3 Beds, 5 in. spheres/bed
Percent Solids Recirculated = 14.0-16.0 wt %
Limestone Addition to TCA Inlet Stream
Discharge (Clarifier) Solids
Concentration = 26-39 wt %

Total Pressure Drop, Excluding Mist Elim.
= 7.7-8.7 in. H_2O
Mist Elim. Pressure Drop = 0.37-0.46 in. H_2O
Air Flow Rate to Oxidizer = 470 acfm
Liquor Flow Rate to Oxidizer = 1800 gpm
Air Eductor Discharged At 10 ft From Bottom of EHT
EHT Residence Time = 23.5 min
EHT Level = 12 ft

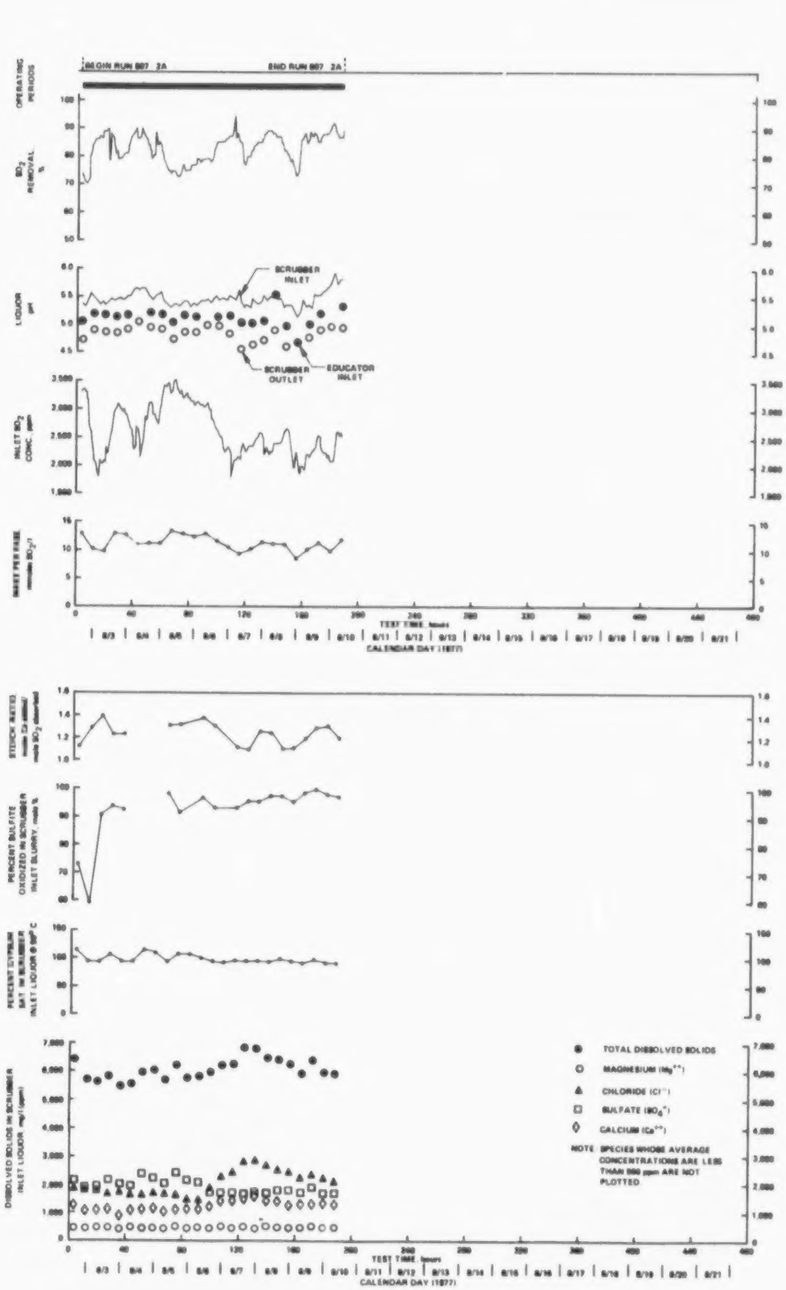
Figure I-36. OPERATING DATA FOR TCA RUN 805-2A



Gas Rate = 30,000 acfm @ 300 °F
Gas Velocity = 12.5 ft/sec
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
3 Beds, 5 in. spheres/bed
Percent Solids Recirculated = 13.9-15.0 wt %
Limestone Addition to TCA Inlet Stream
Discharge (Clarifier) Solids
Concentration = 32-44 wt %

Total Pressure Drop, Excluding Mist Elim.
= 7.9-8.4 in. H_2O
Mist Elim. Pressure Drop = 0.31-0.40 in. H_2O
Air Flow Rate to Oxidizer = 290 scfm
Liquor Flow Rate to Oxidizer = 1200 gpm
Air Eductor Discharged At 10 ft from Bottom of EHT
EHT Residence Time = 23.5 min
EHT Level = 12 ft

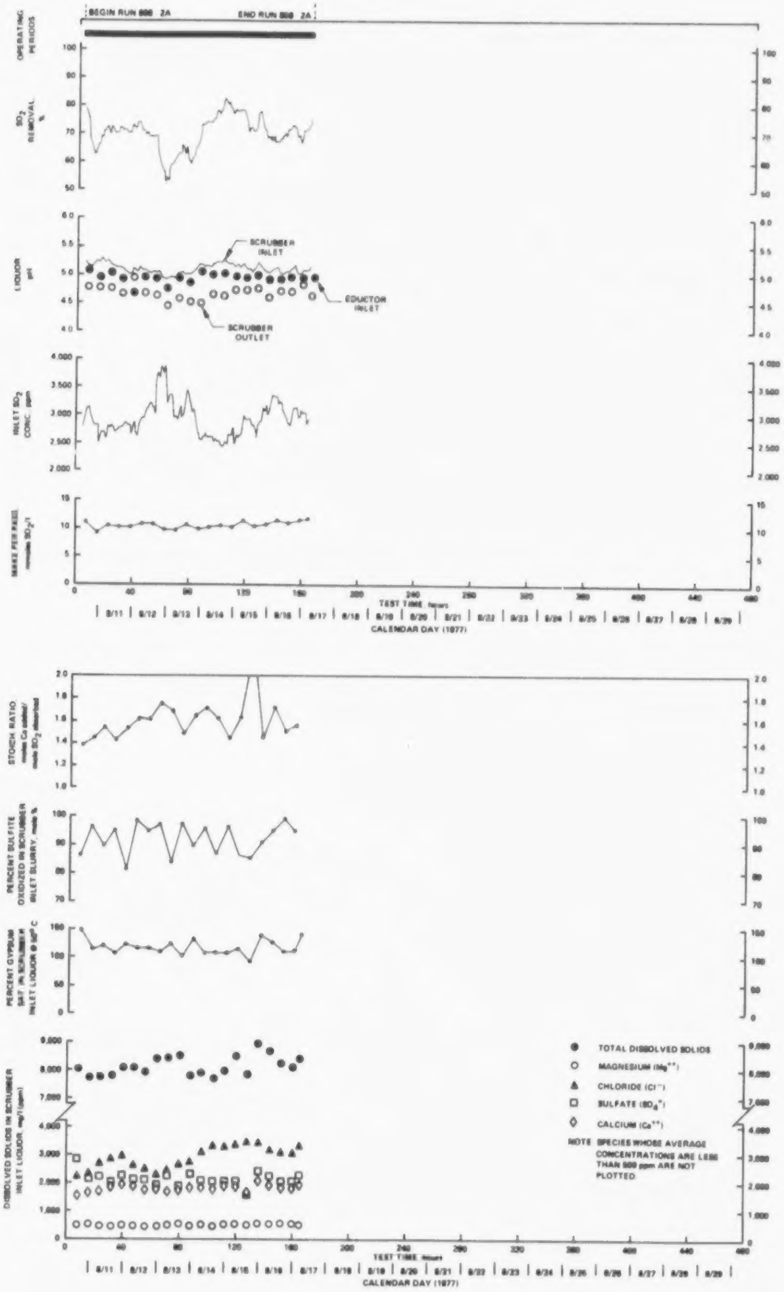
Figure I-37. OPERATING DATA FOR TCA RUN 806-2A



Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
3 Beds, 5 in. spheres/bed
Percent Solids Recirculated = 13.8-16.0 wt %
Limestone Addition to EHT
Discharge (Clarifier) Solids
Concentration = 28-44 wt %

Total Pressure Drop, Excluding Mist Elim.
= 8.2-8.8 in. H_2O
Mist Elim. Pressure d Drop = 0.34-0.44 in. H_2O
Air Flow Rate to Oxidizer = 475 scfm
Liquor Flow Rate to Oxidizer = 1000 gpm
Air Eductor Discharged At 10 ft From Bottom of EHT
EHT Residence Time = 23.5 min
EHT Level = 12 ft
Low pH Tank Residence Time = 2.8 min

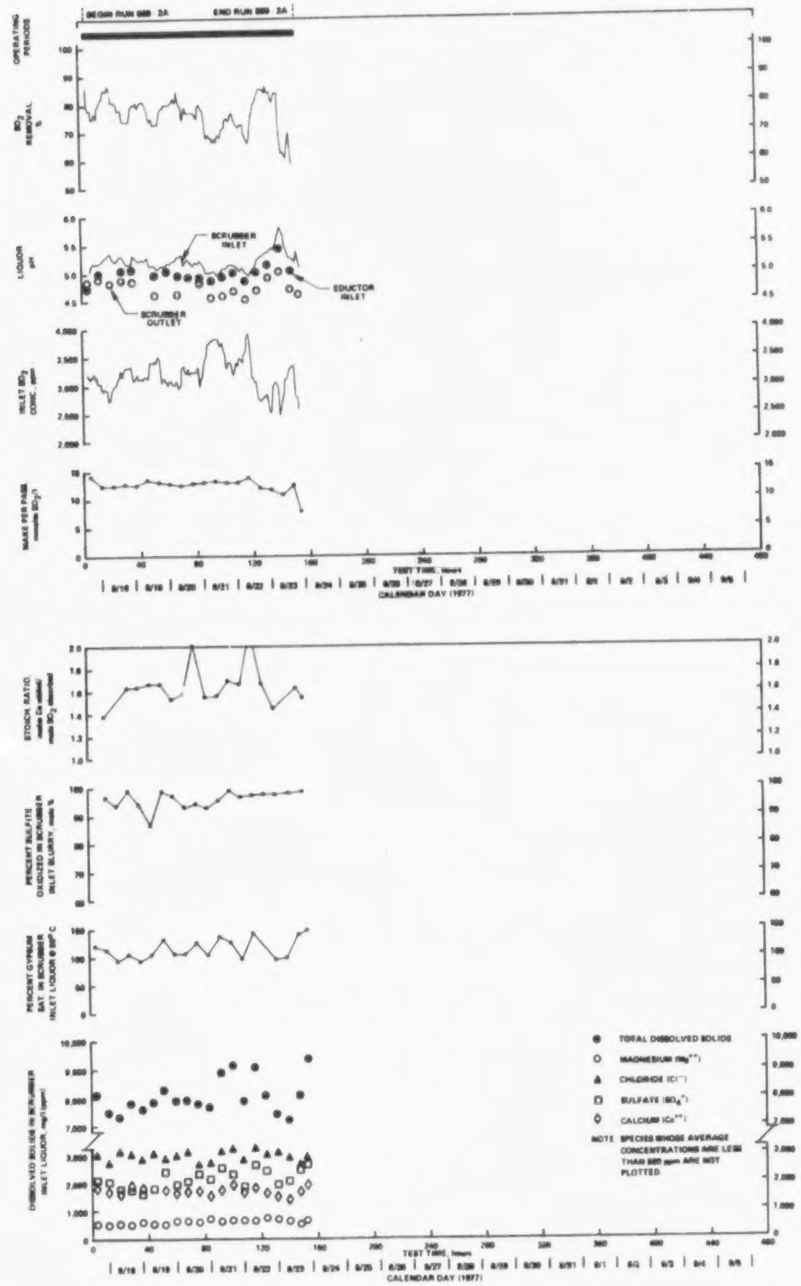
Figure I-38. OPERATING DATA FOR TCA RUN 807-2A



Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
3 Beds, 5 in. spheres/bed
Percent Solids Recirculated = 13.7-15.8 wt %
Limestone Addition to EHT
Discharge (Clarifier) Solids
Concentration = 34-84 wt %

Total Pressure Drop, Excluding Mist Elim.
= 8.0-8.5 in. H_2O
Mist Elim. Pressure Drop = 0.44-0.50 in. H_2O
Air Flow Rate to Oxidizer = 200 acfm
Liquor Flow Rate to Oxidizer = 1600 gpm
Air Eductor Discharged At 10 ft From Bottom of EHT
EHT Residence Time = 23.5 min
EHT Level = 12 ft
Low pH Tank Residence Time = 2.9 min

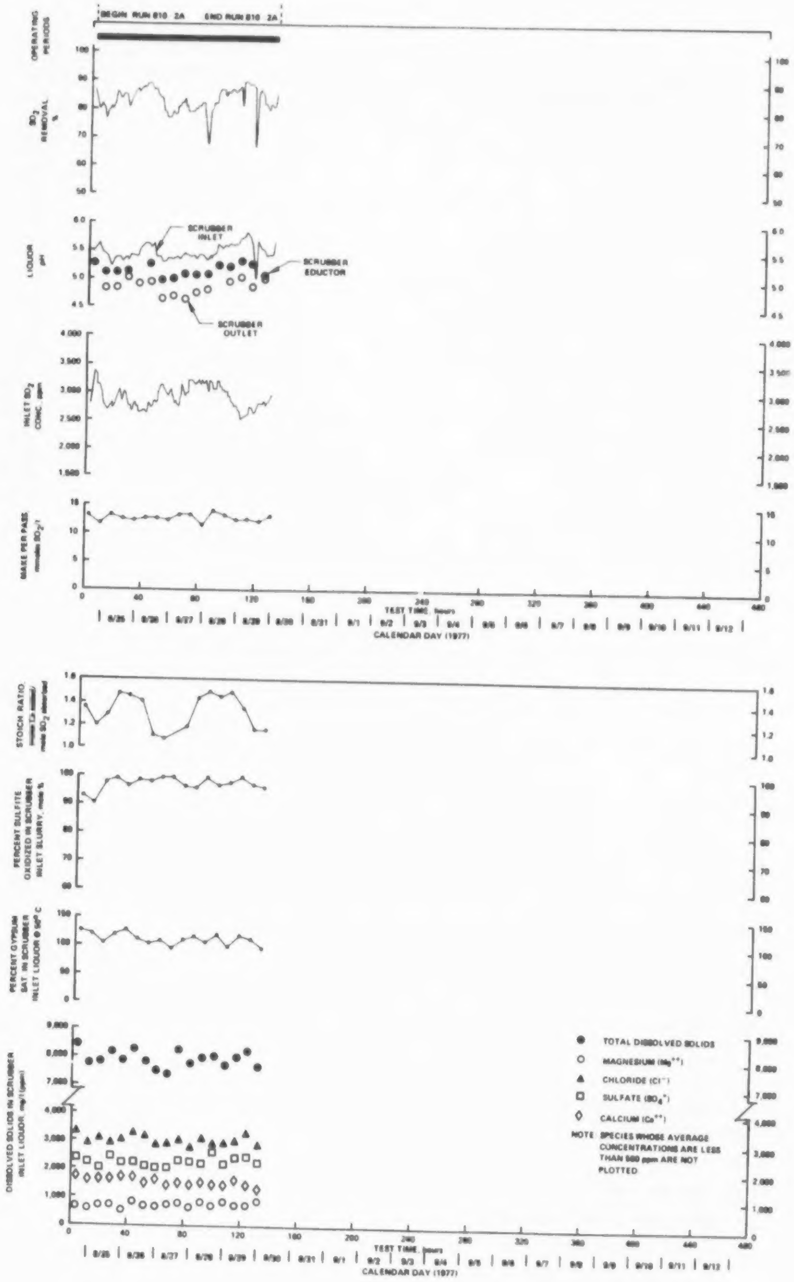
Figure I-39. OPERATING DATA FOR TCA RUN 808-2A



Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec
Liquor Rate = 1200 gpm
L/G = 60 gal/Mcf
3 Beds, 5 in. spheres/bed
Percent Solids Recirculated = 14.1-17.1 wt %
Limestone Addition to EHT
Discharge (Clarifier & Filter) Solids
Concentration = 80-85 wt %

Total Pressure Drop, Excluding Mist Elim.
= 6.0-6.7 in. H_2O
Mist Elim. Pressure Drop = 0.36-0.43 in. H_2O
Air Flow Rate to Oxidizer = 300 scfm
Liquor Flow Rate to Oxidizer = 1000 gpm
Air Eductor Discharged At 6 ft From Bottom of EHT
EHT Residence Time = 15.7 min
EHT Level = 8 ft
Low pH Tank Residence Time = 1.8 min

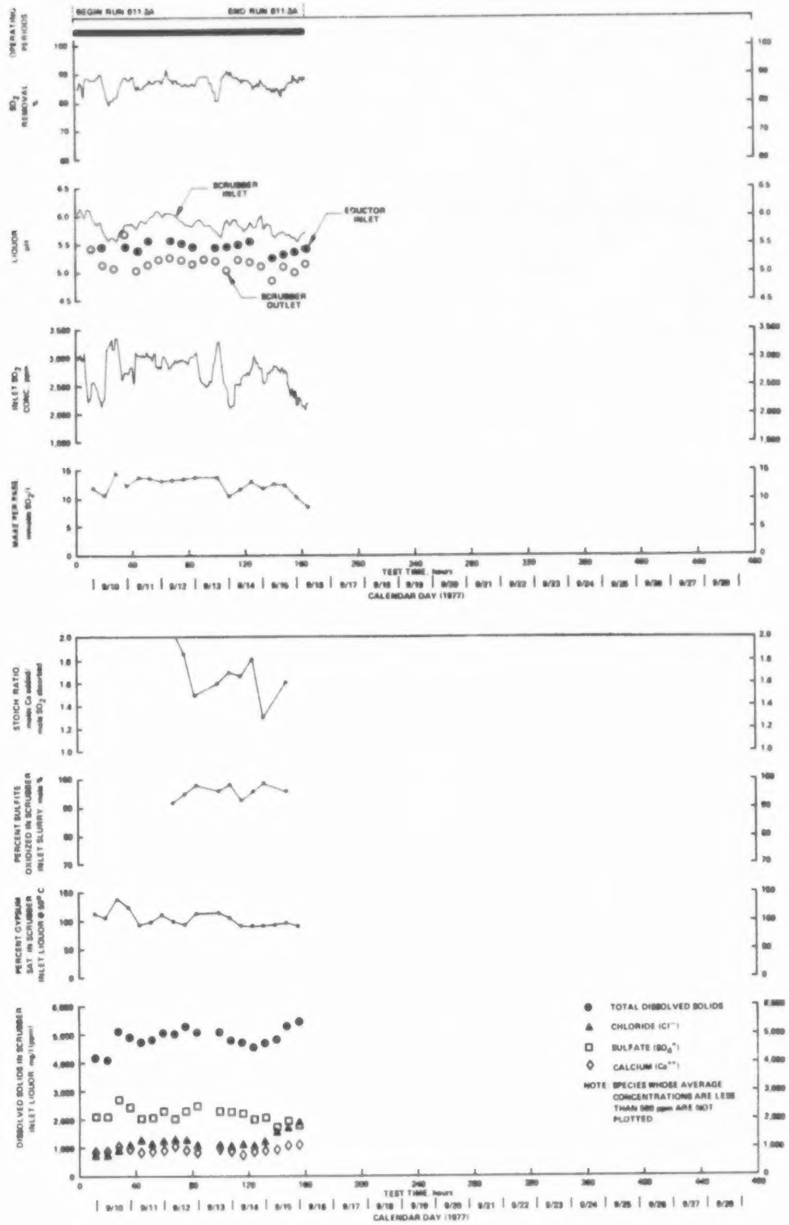
Figure I-40. OPERATING DATA FOR TCA RUN 809-2A



Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
3 Beds, 5 in. spheres/bed
Percent Solids Recirculated = 14.0-15.9 wt %
Limestone Addition to EHT
Discharge (Clarifier & Filter) Solids
Concentration = 84-91 wt %

Total Pressure Drop, Excluding Mist Elim.
= 8.2-9.0 in. H_2O
Mist Elim. Pressure Drop = 0.35-0.45 in. H_2O
Air Flow Rate to Oxidizer = 300 acfm
Liquor Flow Rate to Oxidizer = 1000 gpm
Air Eductor Discharged At 6 ft From Bottom of EHT
EHT Residence Time = 15.7 min
EHT Level = 8 ft
Low pH Tank Residence Time = 1.9 min

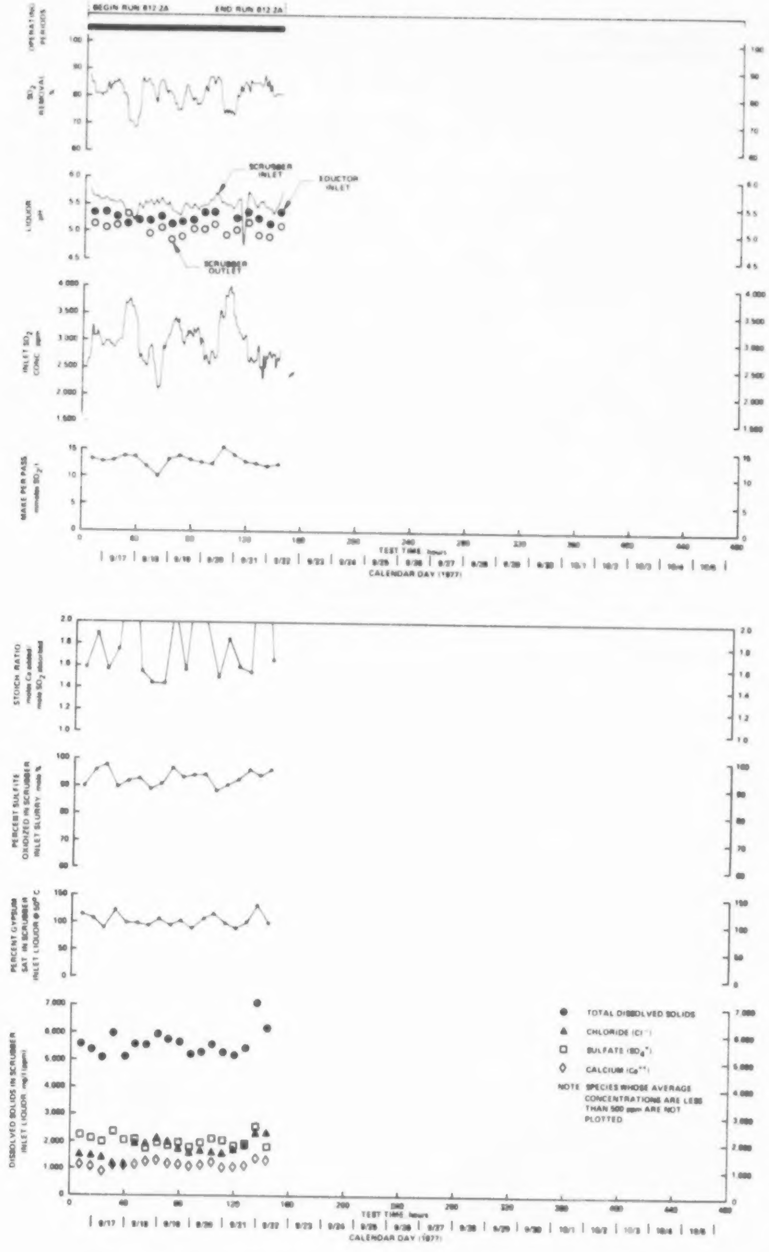
Figure I-41. OPERATING DATA FOR TCA RUN 810-2A



Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
3 Beds, 5 in. spheres/bed
Percent Solids Recirculated = 13.5-15.7 wt %
Limestone Addition to EHT
Discharge (Clarifier) Solids
Concentration = 35-50 wt %

Total Pressure Drop, Excluding Mist Elim.
= 7.6-8.6 in. H_2O
Mist Elim. Pressure Drop = 0.30-0.47 in H_2O
Air Flow Rate to Oxidizer = 270 scfm
Liquor Flow Rate to Oxidizer = 1600 gpm
Air Eductor Discharged at 1. 8 ft From Bottom of EHT
EHT Residence Time = 23.5 min
EHT Level = 12 ft
Low pH Tank Residence Time = 2.9 min

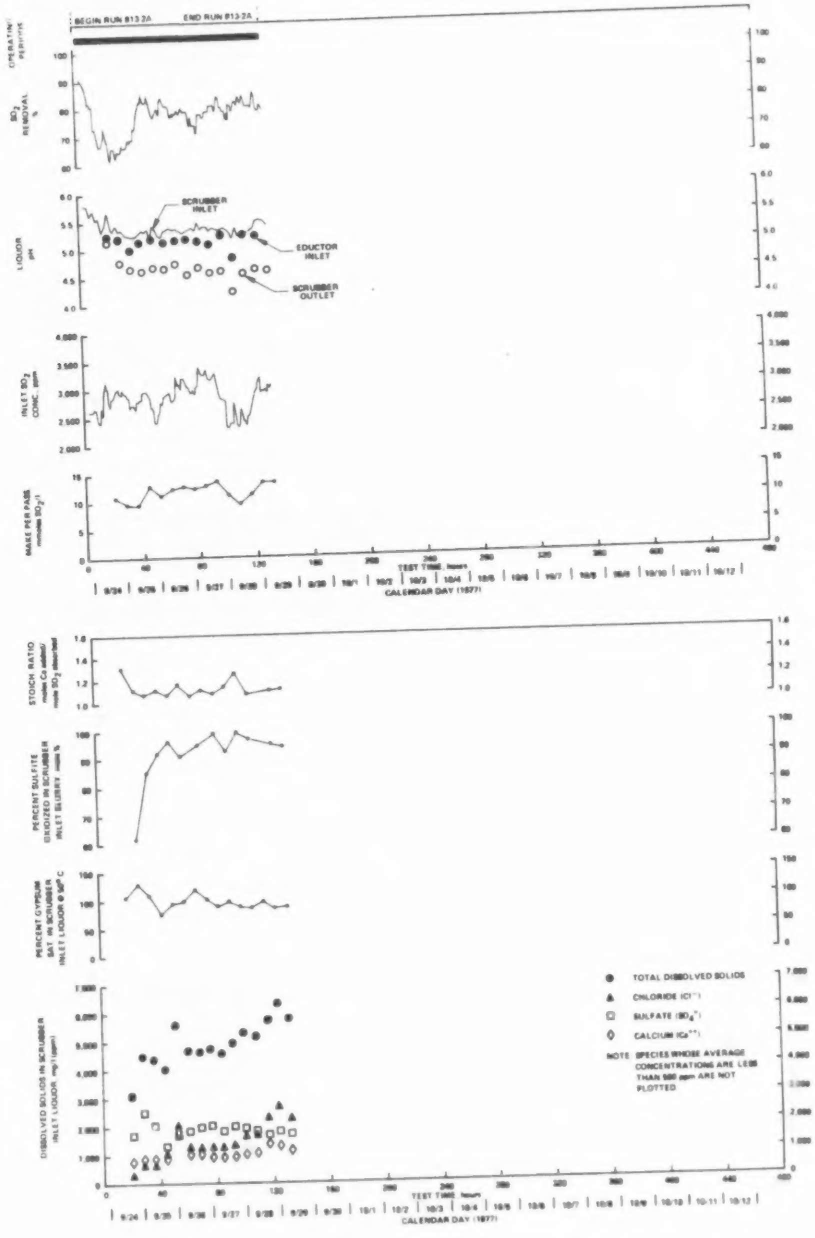
Figure I-42. OPERATING DATA FOR TCA RUN 811-2A



Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec
Liquor Rate = 1200 gpm
L/G =50 gal/Mcf
3 Beds, 5 in. spheres/bed
Percent Solids Recirculated = 13.8-16.1 wt %
Limestone Addition to EHT
Discharge (Clarifier) Solids
Concentration = 32-44 wt %

Total Pressure Drop, Excluding Mist Elim.
= 7.6-8.4 in. H_2O
Mist Elim. Pressure Drop = 0.30-0.50 in. H_2O
Air Flow to Oxidizer = 350 acfm
Liquor Flow Rate to Oxidizer = 1800 gpm
Air Eductor Discharged at 0.8 ft From Bottom of EHT
EHT Residence Time = 15.7 min
EHT Level = 8 ft
Low pH Tank Residence Time = 1.9 min

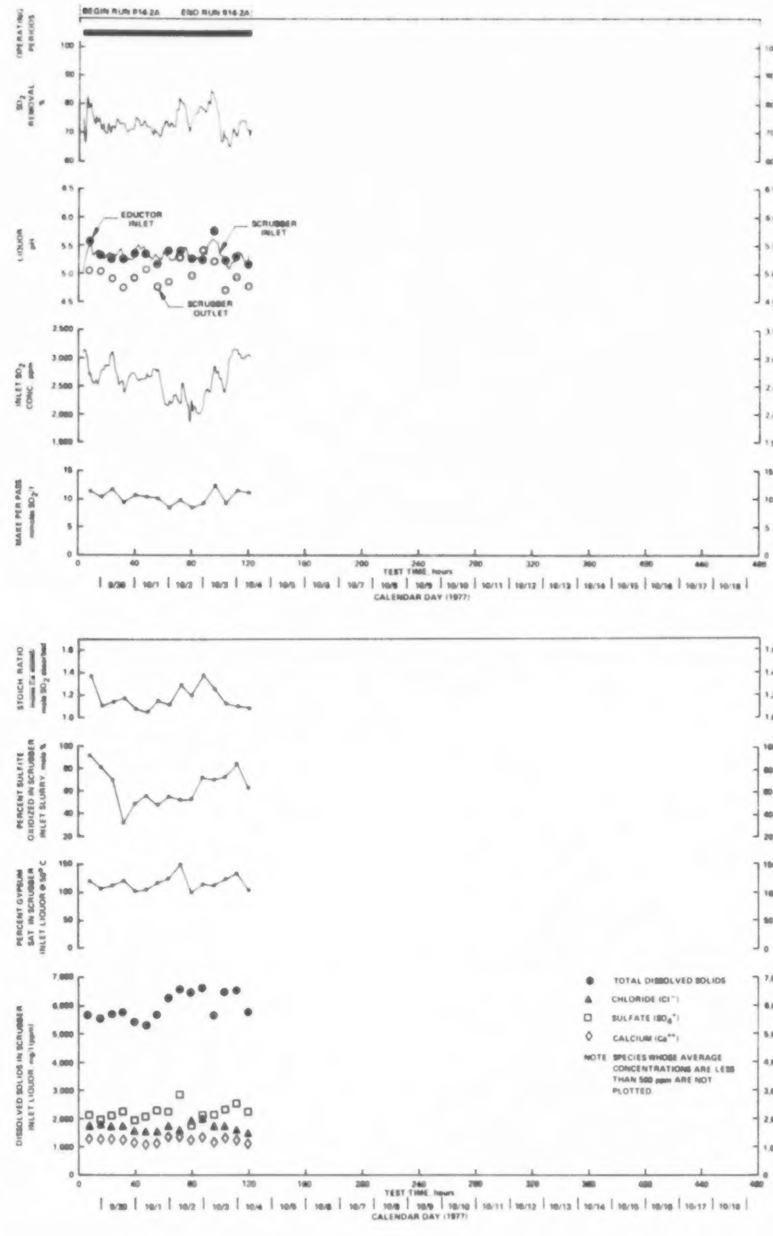
Figure I-43. OPERATING DATA FOR TCA RUN 812-2A



Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
3 Beds, 5 in. spheres/bed
Percent Solids Recirculated = 14.5-15.5 wt %
Limestone Addition to TCA inlet stream
Discharge (Clarifier) Solids
Concentration = 35-44 wt %

Total Pressure Drop, Excluding Mist Elim.
= 8.6-10.7 in H_2O
Mist Elim. Pressure Drop = 0.47-0.58 in. H_2O
Air Flow Rate to Oxidizer = 310 scfm
Liquor Flow Rate to Oxidizer = 1000 gpm
Air Eductor Discharged at 0.8 ft From Bottom of EHT
EHT Residence Time = 23.5 min
EHT Level = 12 ft

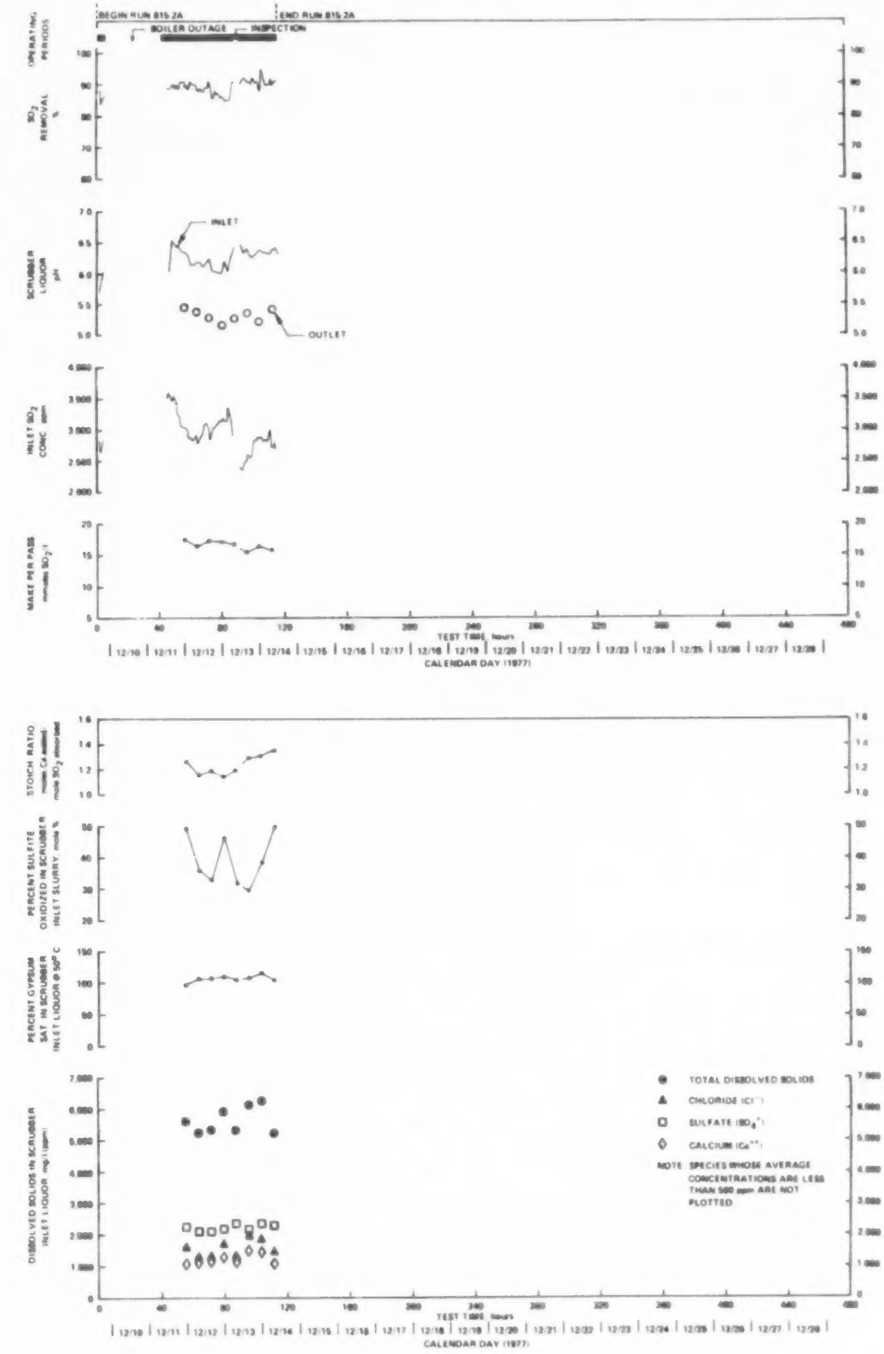
Figure I-44. OPERATING DATA FOR TCA RUN 813-2A



Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
EHT Residence Time = 4.1 min
3 Beds, 5 in. spheres/bed
Percent Solids Recirculated = 14.3-15.0 wt %
Limestone Addition to TCA inlet Stream
Discharge (Clarifier) Solids
Concentration = 33-42 wt %

Total Pressure Drop, Excluding Mist Elim.
= 8.7-10.4 in. H_2O
Mist Elim. Pressure Drop = 0.47-0.56 in H_2O
Air Flow Rate to Oxidizer = 145 scfm
Liquor Flow Rate to Oxidizer = 1200 gpm
Air Eductor Discharged at 0.8 ft From Bottom of EHT
EHT Residence Time = 15.7 min
EHt Level = 8 ft

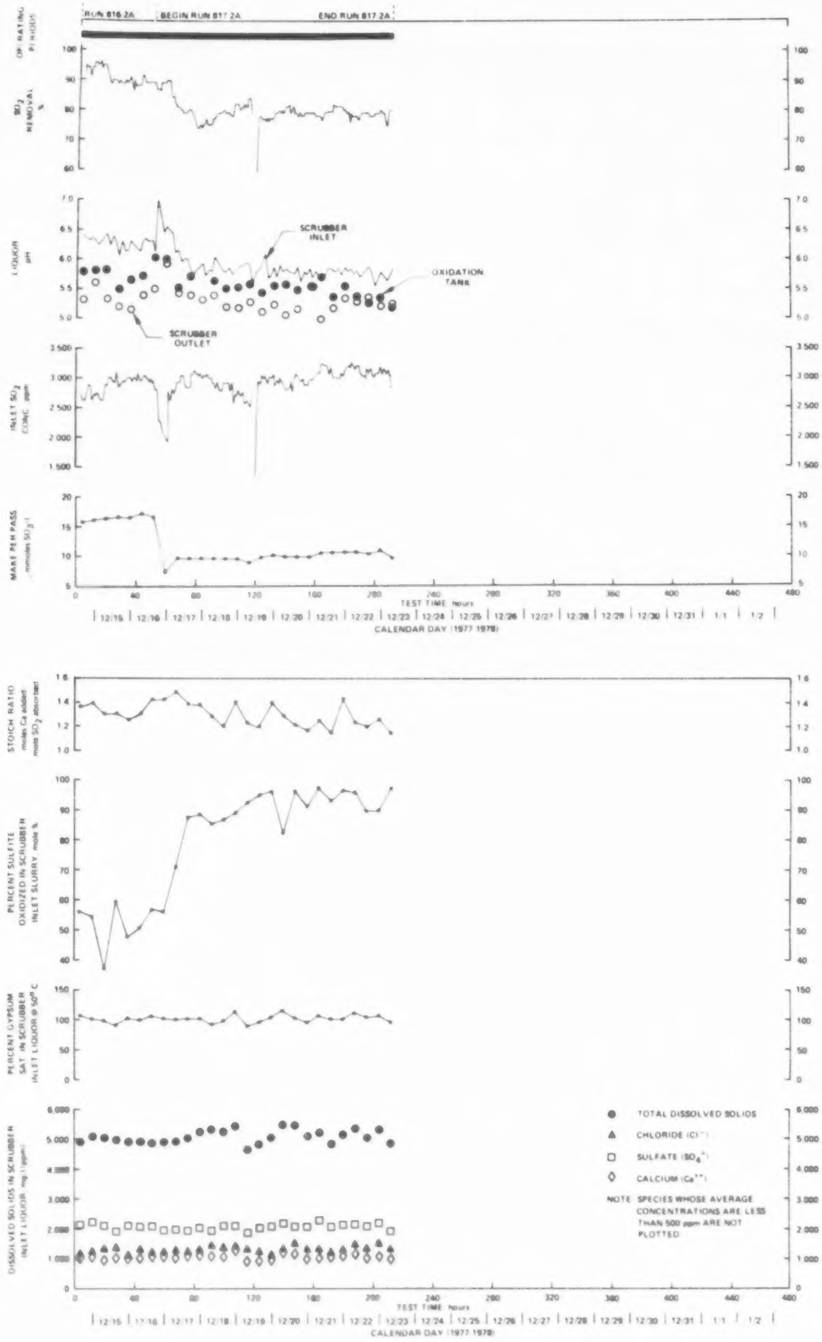
Figure I-45. OPERATING DATA FOR TCA RUN 814-2A



Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec
Liquor Rate = 1000 gpm
L/G = 42 gal/Mcf
3 Beds, 6.7 in. spheres/bed
Percent Solids Recirculated = 14.2-15.6 wt %
Limestone Addition to EHT
Discharge (Clarifier) Solids
Concentration = 35-41 wt %

Total Pressure Drop, Excluding Mist Elim.
= 9.8-14.0 in. H_2O
Mist Elim. Pressure Drop = 0.44-0.54 in. H_2O
Air Flow Rate to Sparger = 130 acfm
Oxidation Tank Level = 18 ft
Oxidation Tank Residence Time = 5.2 min
EHT Residence Time = 14.4 min

Figure I-46. OPERATING DATA FOR TCA RUN 815-2A



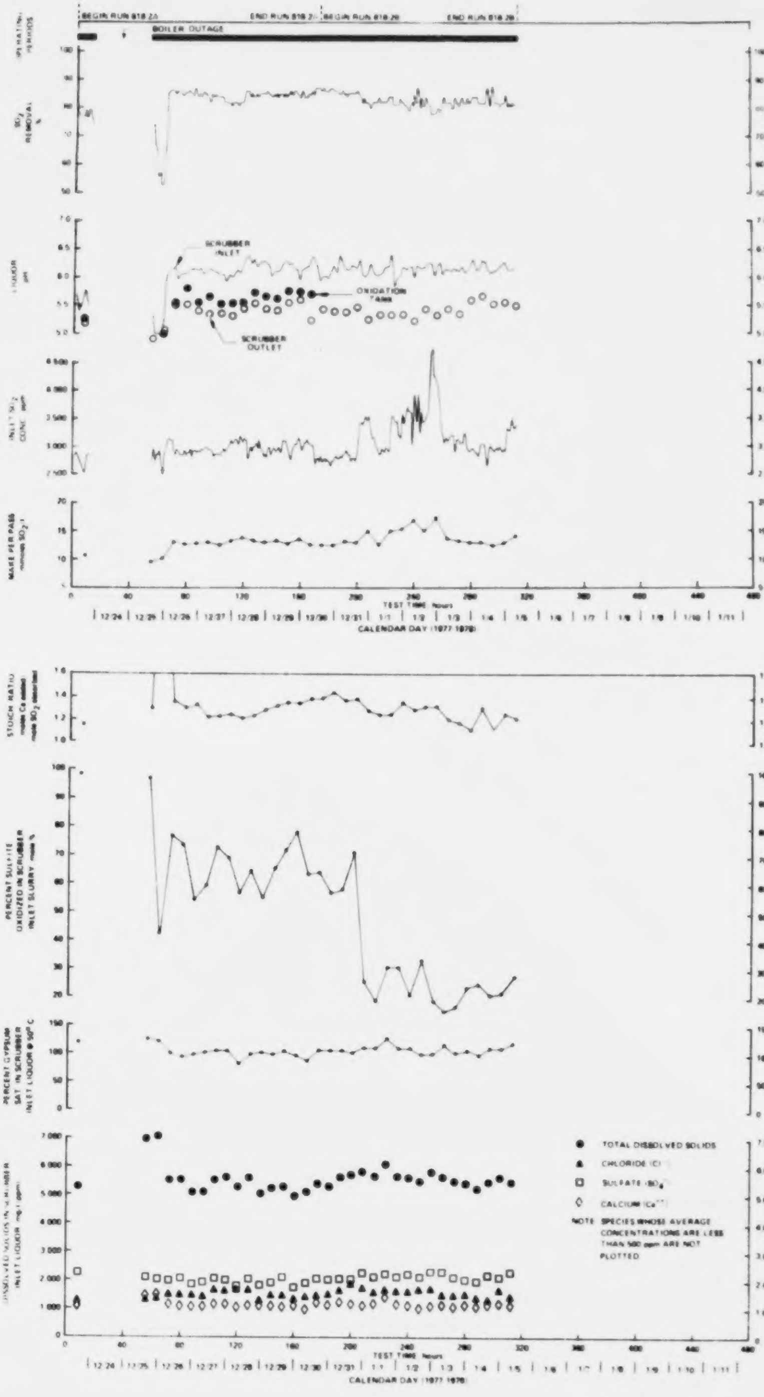
Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec
Liquor Rate = 1000 gpm
L/G = 42 gal/Mcf
3 Beds, 7.5 in. spheres/bed
Percent Solids Recirculated = 14.7-15.7 wt %
Limestone Addition to EHT
Discharge (Clarifier) Solids
Concentration = 38-42 wt %

Total Pressure Drop, Excluding Mist Elim.
= 10.7-15.3 in. H_2O
Mist Elim. Pressure Drop = 0.40-.48 in. H_2O
Air Flow Rate to Sparger = 180/250 scfm
Oxidation Tank Level = 18 ft
Oxidation Tank Residence Time = 5.2 min
EHT Residence Time = 14.4 min

Gas Rate = 20,000 acfm @ 300° F
Gas Velocity = 8.4 ft/sec
Liquor Rate = 1000 gpm
L/G = 62 gal/Mcf
3 Beds, 7.5 in. spheres/bed
Percent Solids Recirculated = 13.6-15.2 wt %
Limestone Addition to EHT
Discharge (Clarifier) Solids
Concentration = 31-48 wt %

Total Pressure Drop, Excluding Mist Elim.
= 6.5-7.2 in. H_2O
Mist Elim. Pressure Drop = 0.16-0.26 in. H_2O
Air Flow Rate to Sparger = 130 scfm
Oxidation Tank Level = 18 ft
Oxidation Tank Residence Time = 5.2 min
EHT Residence Time = 14.4 min

Figure I-47. OPERATING DATA FOR TCA RUNS 816-2A AND 817-2A



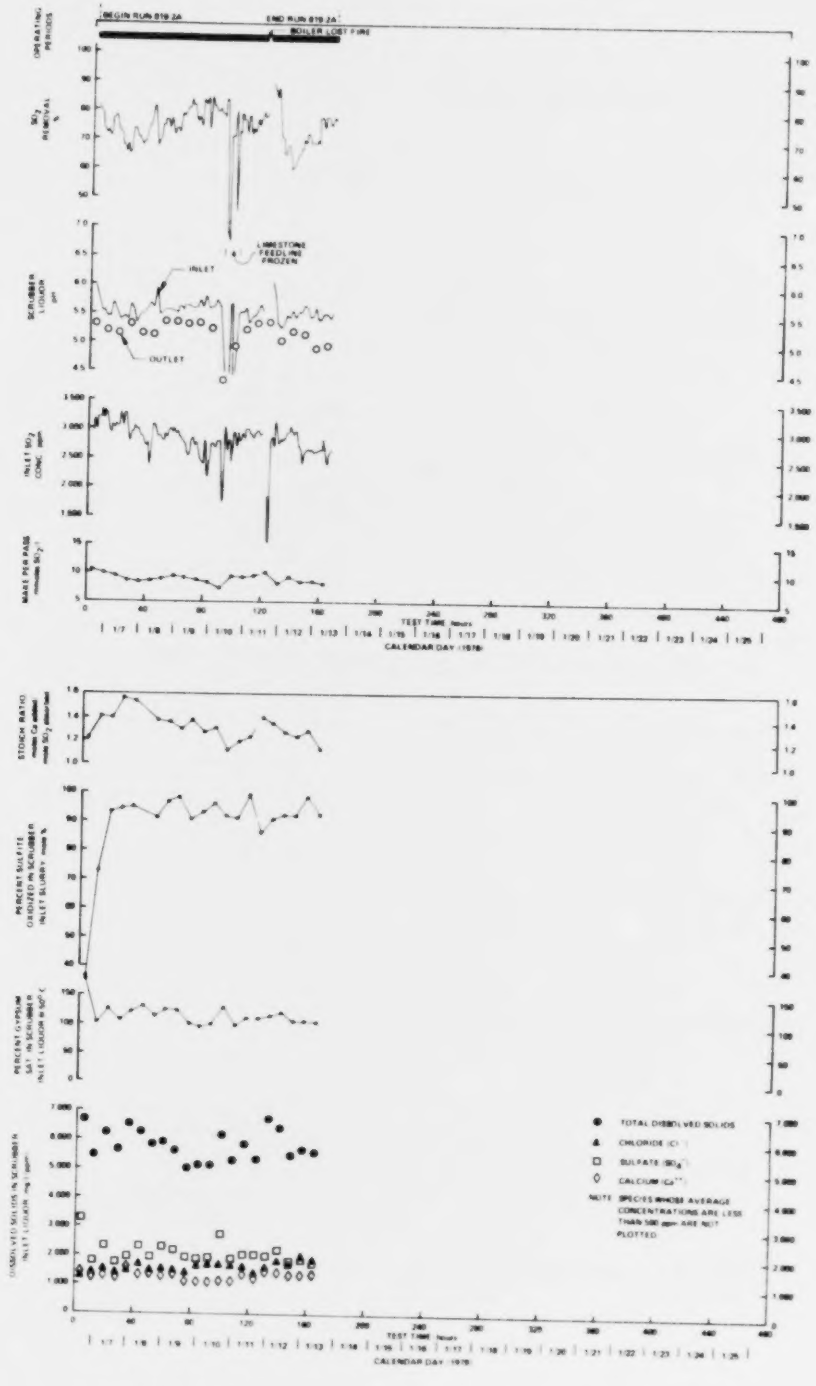
Gas Rate = 25,000 acfm @ 300° F
Gas Velocity = 10.4 ft/sec
Liquor Rate = 1000 gpm
L/G = 50 gal/Mcf
3 Beds, 7.5 in. spheres/bed
Percent Solids Recirculated = 14.2-15.4 wt %
Limestone Addition to EHT
Discharge (Clarifier) Solids
Concentration = 38-42 wt %

Total Pressure Drop, Excluding Mist Elim.
= 7.9-9.2 in. H_2O
Mist Elim. Pressure Drop = 0.26-0.36 in. H_2O
Air Flow Rate to Sparger = 130 scfm
Oxidation Tank Level = 18 ft
Oxidation Tank Residence Time = 5.2 min
EHT Residence Time = 14.4 min

Gas Rate = 25,000 acfm @ 300° F
Gas Velocity = 10.4 ft/sec
Liquor Rate = 1000 gpm
L/G = 50 gal/Mcf
3 Beds, 7.5 in. spheres/bed
Percent Solids Recirculated = 13.8-14.8 wt %
Limestone Addition to EHT
Discharge (Clarifier) Solids
Concentration = 35-42 wt %

Total Pressure Drop, Excluding Mist Elim.
7.8-8.5 in. H_2O
Mist Elim. Pressure Drop = 0.24-0.35 in. H_2O
Air Flow Rate to Sparger = 0 scfm
Oxidation Tank Level = 18 ft
Oxidation Tank Residence Time = 5.2 min
EHT Residence Time = 14.4 min

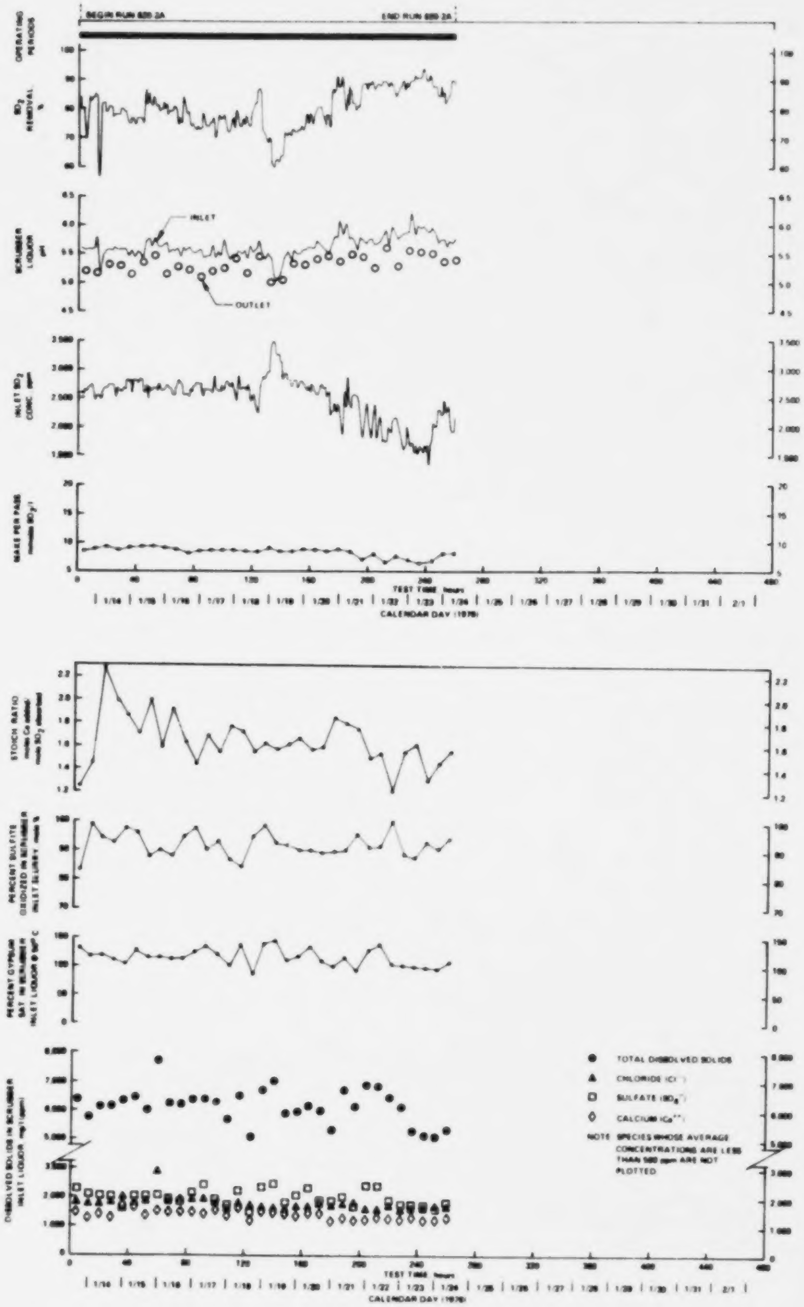
Figure I-48. OPERATING DATA FOR TCA RUNS 818-2A AND 818-2B



Gas Rate = 20,000 acfm @ 300° F
Gas Velocity = 8.4 ft/sec
Liquor Rate = 1000 gpm
L/G = 62 gal/Mcf
3 Beds, 7.5 in. spheres/bed
Percent Solids Recirculated = 11.3-14.5 wt %
Limestone Addition to Oxidation Tank
Discharge (Clarifier) Solids
Concentration = 32-42 wt %

Total Pressure Drop, Excluding Mist Elim.
= 6.6-8.3 in. H_2O
Mist Elim. Pressure Drop = 0.11-0.26 in. H_2O
Air Flow Rate to Sparger = 130 scfm
Oxidation Tank Level = 17 ft
Oxidation Tank Residence Time = 4.9 min

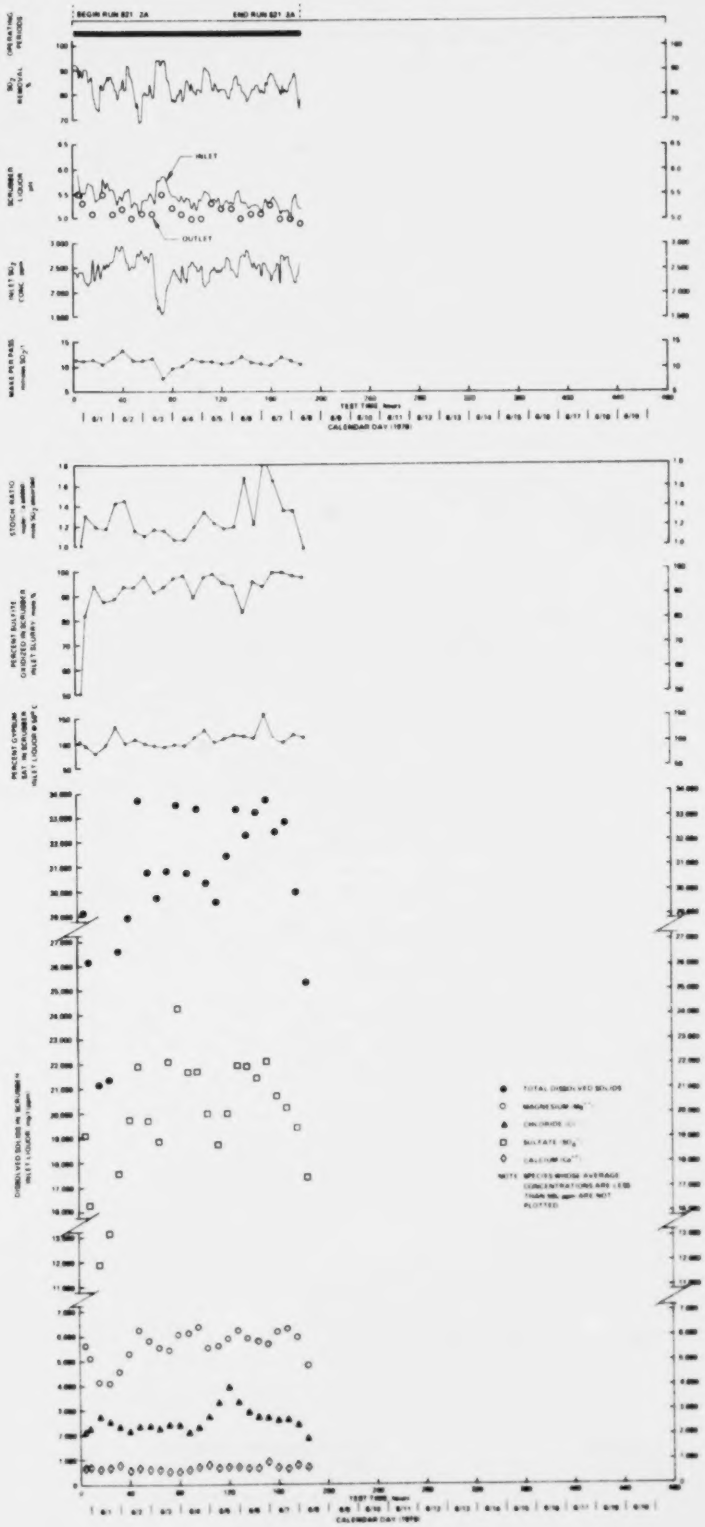
Figure I-49. OPERATING DATA FOR TCA RUN 819-2A



Gas Rate 20,000 acfm @ 300° F
Gas Velocity = 8.4 ft/sec
Liquor Rate = 1000 gpm
L/G = 62 gal/Mcf
3 Beds, 7.5 in. spheres/bed
Percent Solids Recirculated = 11.9-15.7 wt %
Limestone Addition to Oxidation Tank
Discharge (Clarifier) Solids
  Concentration = 32-42 wt %

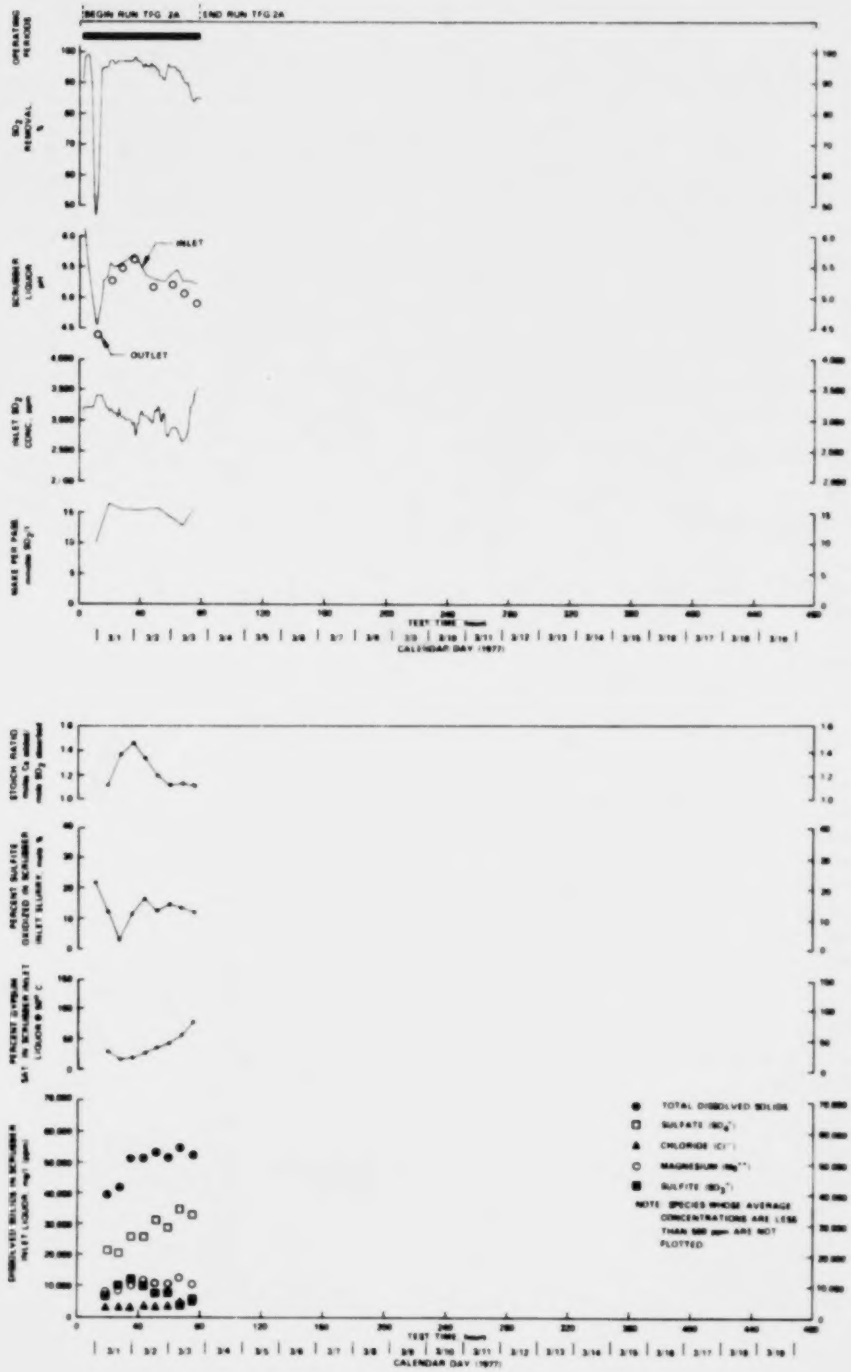
Total Pressure Drop, Excluding Mist Elim.
  = 6.5-7.3 in. H_2O
Mist Elim. Pressure Drop = 0.11-0.21 in. H_2O
Air Flow Rate to Oxidizer = 130 scfm
Oxidation Tank Level = 17 ft
Oxidation Tank Residence Time = 4.9 min

Figure I-50. OPERATING DATA FOR TCA RUN 820-2A



Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec @ 125° F
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
3 Beds, 5 in. spheres/bed
Percent Solids Recirculated = 13.9 - 15.9 wt %
Limestone & Dry MgO Addition to Oxidation Tank
Discharge(Clarifier & Centrifuge) Solids
Concentration = 78 - 80 wt %
Total Pressure Drop, Excluding Mist Elim.
= 7.1 - 8.6 in. H_2O
Mist Elim. Pressure Drop = 0.54 - 0.62 in. H_2O
Air Flow Rate to Oxidizer = 170 acfm
Oxidation Tank Level = 17 ft
Oxidation Tank Residence Time = 4.1 min
External Downcomer used

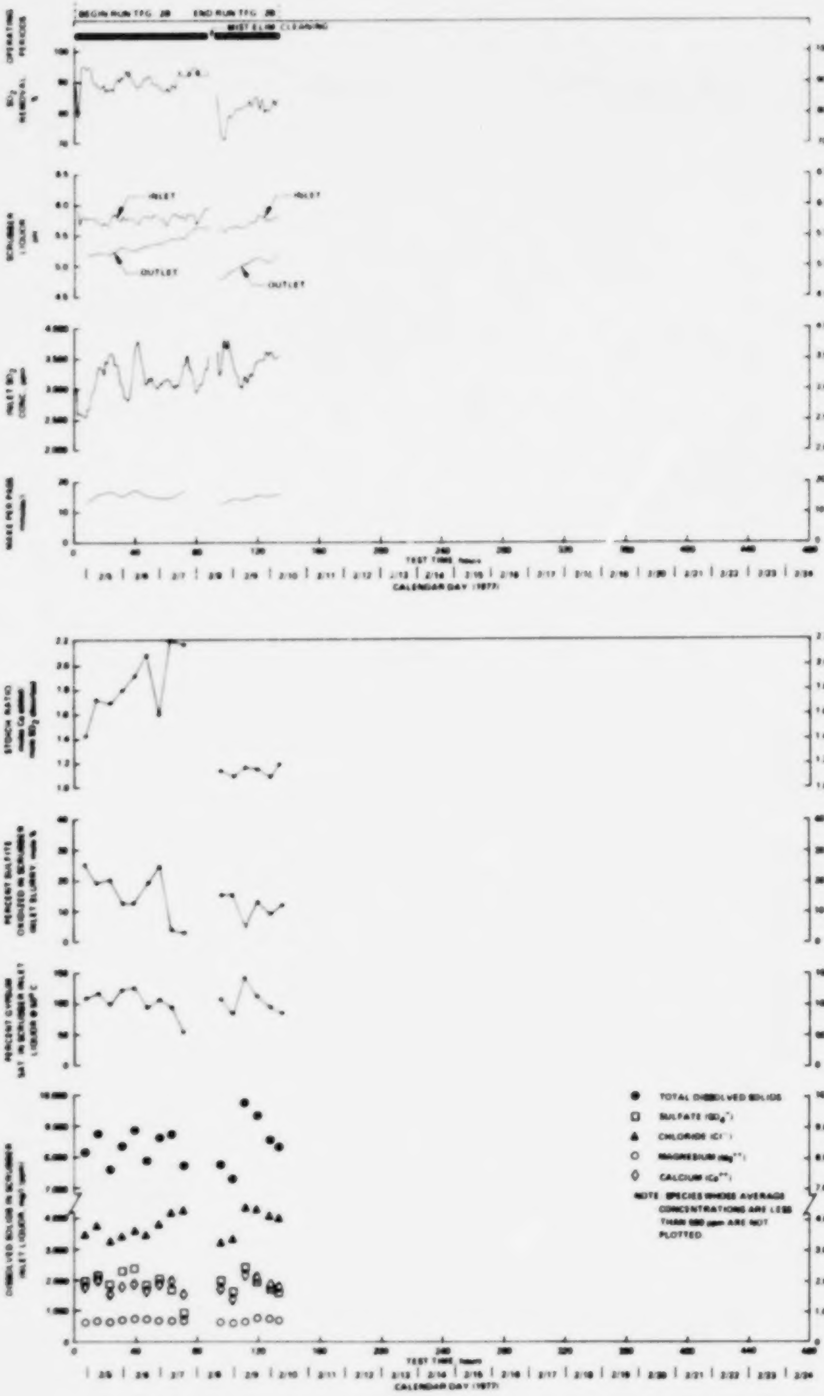
Figure I-51. OPERATING DATA FOR TCA RUN 821-2A



Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
EHT Residence Time = 12 min
3 Beds, 5 in. spheres/bed

Percent Solids Recirculated = 13.5-18.0 wt %
Total Pressure Drop, Excluding Mist Elim.
= 5.9-7.3 in. H_2O
Mist Elim. Pressure Drop = 0.44-0.50 in. H_2O
Discharge (Centrifuge) Solids
Concentration = 50-55 wt %
Limestone and MgO Addition to EHT

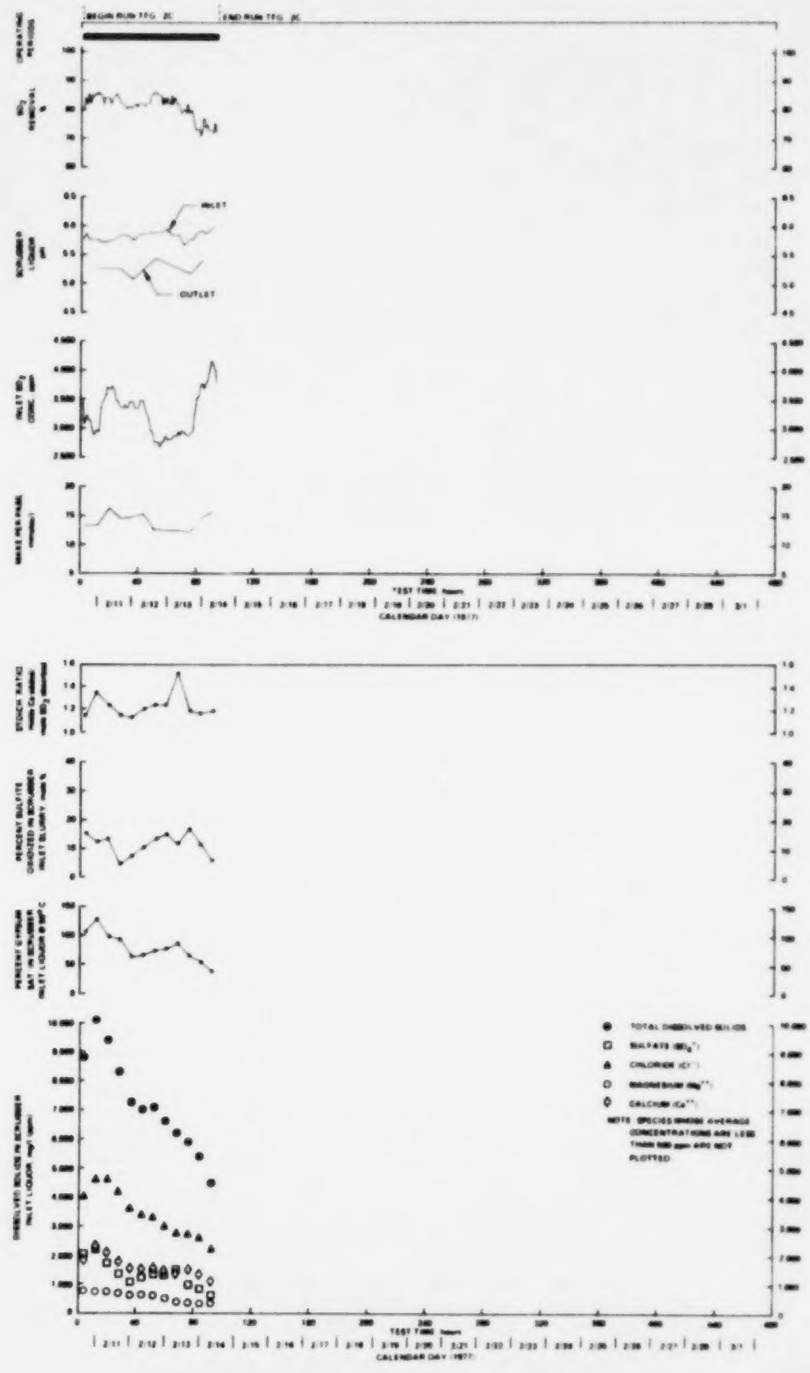
Figure I-52. OPERATING DATA FOR TCA RUN TFG-2A



Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec
Liquor Rate = 1200 gpm
L/G = 90 gal/Mcf
EHT Residence Time = 12 min. (3 tanks)
3 Beds, 5 in. spheres/bed

Percent Solids Recirculated = 14.5-15.6 wt %
Total Pressure Drop, Excluding Mist Elim.
= 8.6-9.8 in. H_2O
Mist Elim. Pressure Drop = 0.56-0.80 in. H_2O
Discharge (Clarifier) Solids
Concentration = 30-39 wt %
Limestone Addition to First EHT

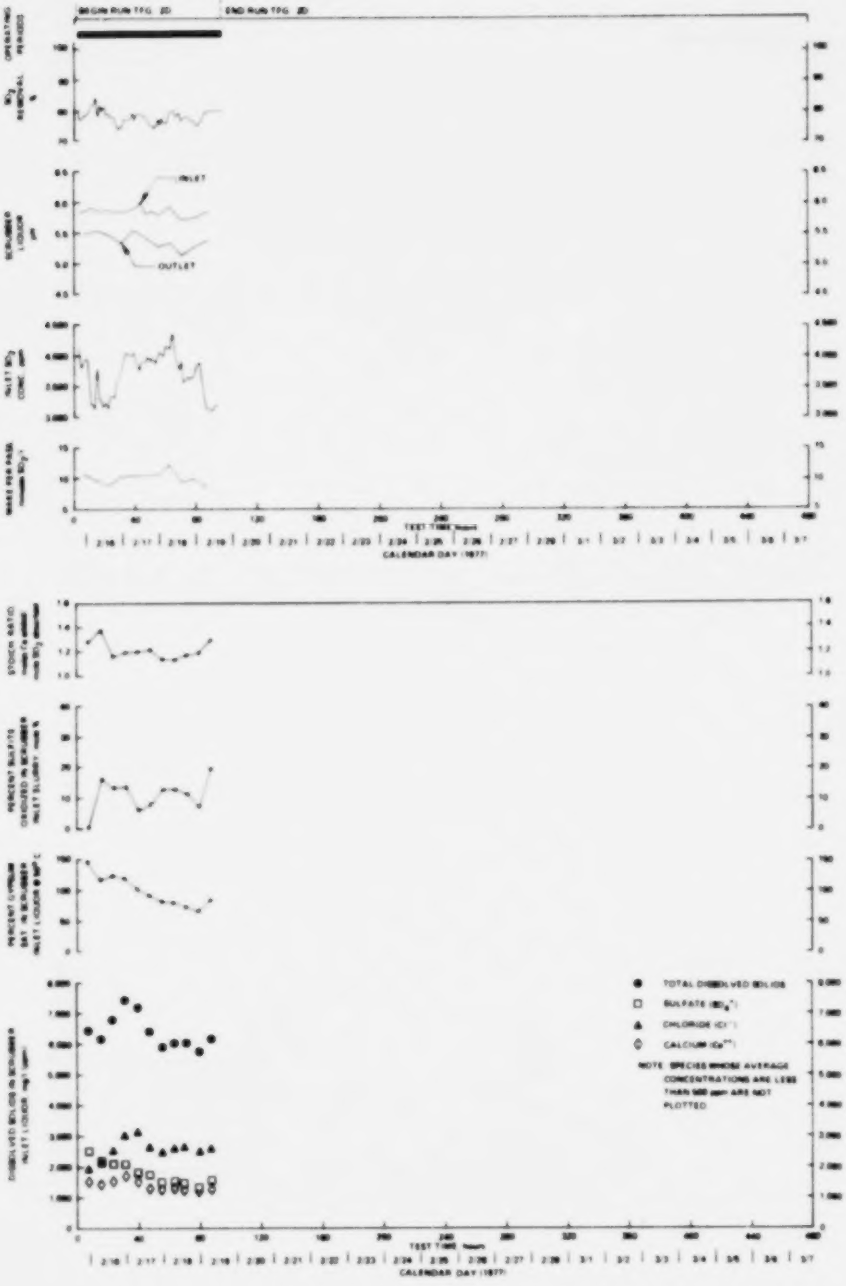
Figure I-53. OPERATING DATA FOR TCA RUN TFG-2B



Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
EHT Residence Time = 12 min (3 tanks)
3 Beds, 5 in. spheres/bed

Percent Solids Recirculated = 14.5-16.3 wt %
Total Pressure Drop, excluding Mist Elim.
 = 7.6-8.5 in. H_2O
Mist Elim. Pressure Drop = 0.49-0.80 in. H_2O
Discharge (Clarifier) Solids
 Concentration = 32-42 wt %
Limestone Addition to First EHT

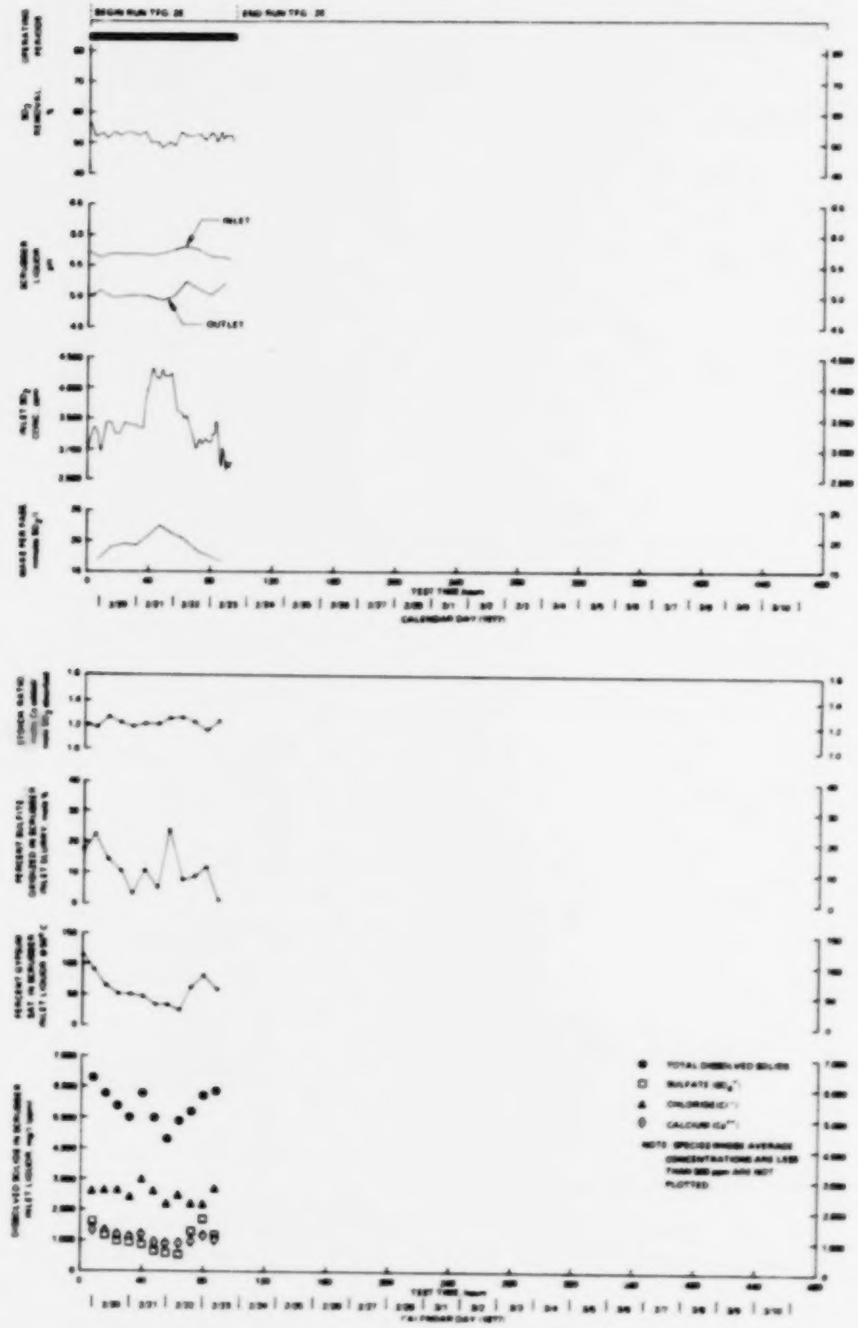
Figure I-54. OPERATING DATA FOR TCA RUN TFG-2C



Gas Rate = 20,000 acfm @ 300° F
Gas Velocity = 8.4 ft/sec
Liquor Rate = 1200 gpm
L/G = 75 gal/Mcf
EHT Residence Time = 12 min. (3 tanks)
3 Beds, 5 in. spheres/bed

Percent Solids Recirculated = 12.8-15.9 wt %
Total Pressure Drop, Excluding Mist Elim.
= 4.6-5.0 in. H_2O
Mist Elim. Pressure Drop = 0.17-0.24 in. H_2O
Discharge (Clarifier) Solids
Concentration = 35-42 wt %
Limestone Addition to First EHT

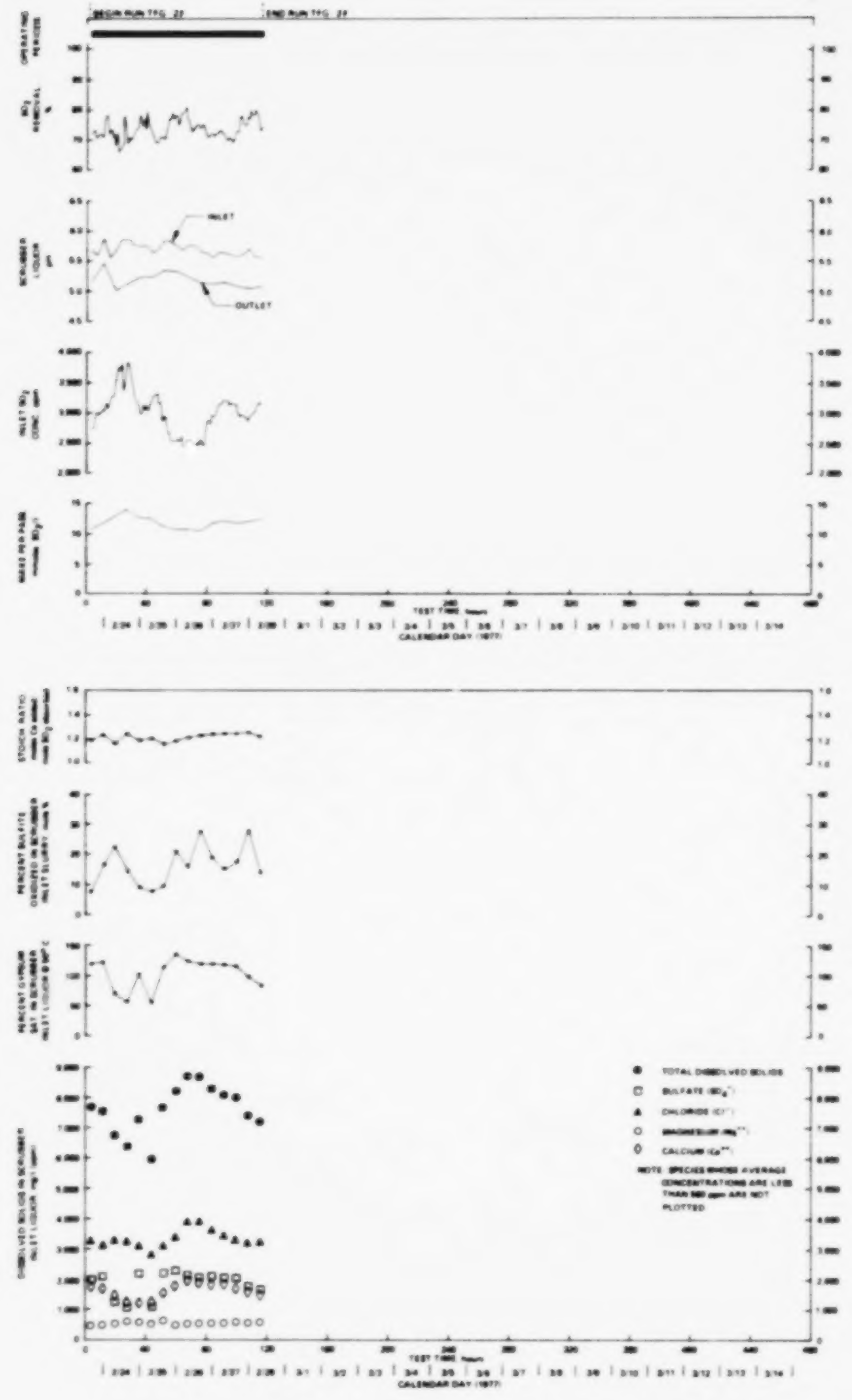
Figure I-55. OPERATING DATA FOR TCA RUN TFG-2D



Gas Rate = 30,000 acfm @ 300°F
Gas Velocity = 12.5 ft/sec
Liquor Rate = 600 gpm
L/G = 25 gal/Mcf
EHT Residence Time = 24 min. (3 tanks)
3 Beds, 5 in. spheres/bed

Percent Solids Recirculated = 13.8-15.1 wt %
Total Pressure Drop, Excluding Mist Elim.
= 4.7-5.1 in. H_2O
Mist Elim. Pressure Drop = 0.48-0.56 in. H_2O
Discharge (Clarifier) Solids
Concentration = 37-43 wt %
Limestone Addition to First EHT

Figure I-56. OPERATING DATA FOR TCA RUN TFG-2E



Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
EHT Residence Time = 12 min. (3 tanks)
3 Beds, 5 in. spheres/bed

Percent Solids Recirculated = 14.1-16.2 wt %
Total Pressure Drop, Excluding Mist Elim.
= 5.8-7.7 in. H_2O
Mist Elim. Pressure Drop = 0.43-0.49 in. H_2O
Discharge (Clarifier) Solids
Concentration = 34-42 wt %
Limestone Addition to First EHT

Figure I-57. OPERATING DATA FOR TCA RUN TFG-2F

Appendix J

AVERAGE LIQUOR COMPOSITIONS FOR THE TCA TESTS

The values in these tables are averages for steady-state operating periods.

Percent sulfite oxidized is measured in the bleed stream from the scrubber system.

Calculated Percent Gypsum Saturation = (activity Ca^{++}) x (activity $SO_4^{=}$)/ (solubility product at 50°C). Estimated solubility product for $CaSO_4 \cdot 2H_2O$ at 50°C is 2.2×10^{-5} (ref. Radian Corporation, "A Theoretical Description of the Limestone-Injection Wet Scrubbing Process, NAPCA Report June 9, 1970).

Run No.	Percent Solids Discharged	Percent Sulfite Oxidized	Sample Point	pH	Liquor Species Concentration, mg/l (ppm)								Calculated Percent Gypsum Saturation @ 50°C	Percent Error In Ionic Imbalance
					Ca^{++}	Mg^{++}	Na^{+}	K^{+}	$SO_3^{=}$	$SO_4^{=}$	Cl^{-}	Total		
590-2A	66	45	TCA Inlet	5.00	1465	355	55	60	770	1825	1875	6405	110	4.4
			TCA Outlet	4.85	1520	315	55	65	940	2160	1800	6855	130	-2.3
590-2B	58	31	TCA Inlet	5.30	1490	390	45	70	270	2000	1835	6100	120	11.7
			TCA Outlet	5.10	1540	400	45	65	470	2080	1885	6485	120	9.2
591-2A	57	43	TCA Inlet	5.50	615	5405	55	80	2000	19275	1375	28805	105	1.8
			TCA Outlet	5.30	670	5335	60	80	2775	18885	1405	29210	115	0.6
592-2A	55	25	TCA Inlet	5.40	605	9730	45	65	4360	31050	2505	48360	105	5.6
			TCA Outlet	5.20	660	9640	45	60	5135	30610	2495	48645	115	5.3
593-2A	57	24	TCA Inlet	5.45	535	10295	55	65	4855	30755	3795	50355	85	5.6
			TCA Outlet	5.20	605	10085	55	65	5700	29490	3830	49830	95	6.3
594-2A	53	18	TCA Inlet	5.35	555	10175	50	70	5370	30555	3575	50350	90	5.2
			TCA Outlet	5.15	650	10005	50	70	6420	30110	3650	50955	105	3.8

Run No.	Percent Solids Discharged	Percent Sulfite Oxidized	Sample Point	pH	Liquor Species Concentration, mg/l (ppm)								Calculated Percent Gypsum Saturation @ 50^oC	Percent Error In Ionic Imbalance
					Ca^{++}	Mg^{++}	Na^+	K^+	$SO_3^=$	$SO_4^=$	Cl^-	Total		
618-2A	63	28	TCA Inlet	7.00	1600	360	45	70	85	1985	2335	6480	120	3.7
			TCA Outlet	4.95	1940	375	45	70	870	2455	2345	8100	155	1.7
618-2B	59	30	TCA Inlet	7.05	1535	380	45	80	80	1995	2390	6505	120	1.1
			TCA Outlet	5.60	1665	375	45	85	450	2120	2380	7120	130	-0.2
619-2A	56	23	TCA Inlet	7.00	595	3100	45	80	355	10815	2165	17155	90	-2.0
			TCA Outlet	5.8	720	3070	45	85	1110	10805	2170	18005	105	-4.1
620-2A	56	27	TCA Inlet	7.2	630	2735	45	75	330	9860	1885	15560	95	-2.3
			TCA Outlet	5.8	725	2725	45	80	915	10055	1880	16425	110	-5.1
621-2A	55	29	TCA Inlet	7.05	660	2685	50	80	310	10185	1600	15570	105	-2.5
			TCA Outlet	5.65	800	2695	50	85	1025	10085	1600	16340	120	-2.0
622-2A	38/55	22	TCA Inlet	6.95	620	5280(a)	40	50	940	17205	2235	26370	95	5.3
			TCA Outlet	5.40	725	5275	40	50	2090	16800	2285	27265	110	5.3
622-2B	42/60	14	TCA Inlet	6.95	705	2665	30	55	465	8850	1490	14260	95	7.7
			TCA Outlet	5.55	970	2675	30	55	1300	9135	1525	15690	135	6.7
623-2A	59	14	TCA Inlet	7.05	510	2735	30	60	410	9050	1605	14400	70	3.9
			TCA Outlet	5.40	670	2670	25	60	1415	8970	1615	15425	95	1.0
624-2A	42	15	TCA Inlet	7.00	520	2640	30	65	480	7965	2015	13715	65	4.9
			TCA Outlet	5.15	860	2610	30	70	1810	8205	2020	15605	115	2.9

Run No.	Percent Solids Discharged	Percent Sulfite Oxidized	Sample Point	pH	Liquor Species Concentration, mg/l (ppm)								Calculated Percent Gypsum Saturation @ 50^{o}C	Percent Error In Ionic Imbalance
					Ca^{++}	Mg^{++}	Na^{+}	K^{+}	$SO_3^{=}$	$SO_4^{=}$	Cl^{-}	Total		
701-2A	37	12	TCA Inlet	5.80	1680	300	26	74	102	670	3160	6010	45	6.1
			TCA Outlet	5.20	1680	295	26	73	120	715	3110	6020	50	6.3
702-2A	38	7	TCA Inlet	5.85	1075	600	29	42	64	460	3040	5310	20	8.6
			TCA Outlet	5.30	1080	615	29	43	101	510	3090	5470	25	7.3
703-2A	48	7	TCA Inlet	5.65	1200	545	24	32	140	460	3180	5580	25	4.9
			TCA Outlet	5.10	1245	550	25	33	355	585	3220	6020	30	1.4
704-2A	43	13	TCA Inlet	5.70	1510	565	23	24	145	1240	3210	6720	65	3.9
			TCA Outlet	5.00	1575	560	23	24	395	1370	3240	7190	75	0.9
705-2A	36	11	TCA Inlet	5.85	1240	630	23	22	140	1280	2860	6200	60	4.9
			TCA Outlet	5.20	1280	640	23	22	235	1300	2900	6400	60	5.1
706-2A	36	18	TCA Inlet	5.55	1730	685	29	32	130	2290	3230	8130	120	2.8
			TCA Outlet	5.05	1810	700	29	33	240	2450	3340	8600	130	1.1
707-2A	40	17	TCA Inlet	5.60	1410	550	20	39	100	1905	2825	6850	100	-2.8
			TCA Outlet	5.20	1430	545	21	41	121	1915	2825	6900	100	-2.5
708-2A	40	14	TCA Inlet	5.20	1370	455	39	56	405	2220	1970	6520	115	1.4
			TCA Outlet	4.90	1690	470	38	57	830	2380	2015	7480	140	6.8
709-2A	39	20	TCA Inlet	5.35	1230	410	39	61	310	2090	1670	5815	110	3.3
			TCA Outlet	4.95	1315	400	40	65	625	2155	1700	6305	115	0.8
710-2A	43	16	TCA Inlet	5.40	1340	440	49	53	320	2095	1740	6035	110	8.6
			TCA Outlet	4.95	1475	435	48	53	760	2255	1690	6715	125	7.1
711-2A	38	15	TCA Inlet	5.65	1245	485	50	54	93	1525	2185	5635	80	10.3
			TCA Outlet	--	--	--	--	--	--	--	--	--	--	--
712-2A	40	18	TCA Inlet	5.85	995	430	43	61	91	1280	2000	4905	60	4.5
			TCA Outlet	5.15	1010	420	42	61	129	1310	1995	4965	65	3.6
713-2A	40	18	TCA Inlet	5.75	965	370	23	28	135	1995	1145	4660	95	5.5
			TCA Outlet	5.25	980	375	23	30	150	2065	1150	4775	100	4.8
714-2A	36	17	TCA Inlet	5.80	995	495	80	90	135	1735	1765	5270	75	7.0
			TCA Outlet	5.40	985	480	85	85	165	1725	1745	5270	75	7.0
715-2A	36	21	TCA Inlet	5.70	1400	420	60	50	125	1820	2290	5065	100	3.0
			TCA Outlet	5.20	1415	415	60	50	185	1975	2225	7325	110	2.0
716-2A	37	25	TCA Inlet	5.8	1350	415	50	55	140	1960	2075	6045	105	3
			TCA Outlet	5.2	1380	415	50	55	200	2080	2170	6350	115	-1
717-2A	38	22	TCA Inlet	5.9	1240	440	50	55	135	1690	2115	5725	90	4
			TCA Outlet	5.4	1260	435	50	55	170	1770	2095	5835	95	4
718-2A	38	21	TCA Inlet	5.75	1490	455	50	75	125	1995	2355	6545	110	5
719-2A	38	19	TCA Inlet	5.75	1130	410	35	55	165	2080	1500	5375	105	5
			TCA Outlet	5.2	1180	410	40	55	275	2185	1495	5640	110	4

Run No.	Percent Solids Discharged	Percent Sulfite Oxidized	Sample Point	pH	Liquor Species Concentration, mg/l (ppm)								Calculated Percent Gypsum Saturation @ 50°C	Percent Error In Ionic Imbalance
					Ca^{++}	Mg^{++}	Na^{+}	K^{+}	$SO_3^{=}$	$SO_4^{=}$	Cl^{-}	Total		
801-2A and	40	53/63	TCA Inlet	5.82	965	375	27	66	135	2335	1030	4835	105	4.8
801-2B			TCA Outlet	5.16	1060	365	32	64	425	2410	1010	5365	115	1.7
802-2A	35	56	TCA Inlet	5.80	1070	380	42	41	110	1990	1470	5105	100	3.1
			TCA Outlet	5.00	1155	380	42	52	330	2210	1455	5625	115	0.6
803-2A	41	91	TCA Inlet	5.05	1160	480	52	52	140	2165	1850	5900	105	1.8
			TCA Outlet	3.30	1250	480	53	53	510	2265	1840	6455	110	0.4
804-2A	40	93	TCA Inlet	5.05	1345	555	59	82	65	2080	2320	6505	105	6.6
			TCA Outlet	3.90	1470	555	59	81	350	2345	2355	7215	120	3.5
805-2A	33	93	TCA Inlet	5.30	1120	540	80	85	190	2335	1580	5930	105	9.5
			TCA Outlet	4.60	1295	550	80	79	650	2675	1575	6905	130	5.9
806-2A	38	58	TCA Inlet	5.35	1355	520	80	60	435	2170	2010	6630	110	6.1
			TCA Outlet	4.80	1460	545	80	60	870	2245	1905	7165	115	8.6
807-2A	36	96	TCA Inlet	5.4	1280	510	85	70	120	1960	2100	6125	100	8.5
			TCA Outlet	4.9	1475	490	85	70	455	2355	2075	7005	125	4.8
808-2A	44	93	TCA Inlet	5.1	1835	515	95	70	625	2110	2920	8170	125	3.3
			TCA Outlet	4.7	2025	525	95	70	1100	2265	2920	9000	135	4.0
809-2A	85	96	TCA Inlet	5.3	1720	640	105	95	425	2170	2970	8125	115	6.9
			TCA Outlet	4.7	1925	635	105	95	930	2435	2995	9120	135	5.0
810-2A	88	98	TCA Inlet	5.5	1585	755	100	100	95	2280	3050	7965	110	8.8
			TCA Outlet	4.9	1780	750	105	105	570	2530	3015	8855	130	11.0
811-2A	43	96	TCA Inlet	5.8	960	390	65	65	55	2185	1290	5010	100	2
			TCA Outlet	5.2	1130	395	65	65	425	2550	1230	5860	125	0
812-2A	38	93	TCA Inlet	5.6	1140	410	65	65	140	1980	1700	5500	100	4
			TCA Outlet	5.1	1345	410	65	65	605	2210	1625	6325	120	5
813-2A	40	95	TCA Inlet	5.3	1030	390	60	55	60	1855	1620	5070	90	3
			TCA Outlet	4.6	1195	355	55	50	475	2015	1385	5530	110	6
814-2A	38	61	TCA Inlet	5.4	1240	410	70	55	385	2195	1655	6010	115	2
			TCA Outlet	5.0	1305	390	65	55	735	2235	1675	6460	120	2
815-2A	38	40	TCA Inlet	6.25	1225	460	45	60	130	2135	1545	5600	110	12
			TCA Outlet	5.35	1255	450	45	60	210	2220	1375	5615	115	14
816-2A	40	54	TCA Inlet	6.25	1015	410	40	55	90	2095	1230	4935	100	8
			TCA Outlet	5.35	1065	435	40	55	260	2135	1215	5205	100	10
817-2A	40	94	TCA Inlet	5.8	1035	405	40	60	135	2080	1315	5070	100	6
			TCA Outlet	5.2	1195	385	45	60	455	2305	1285	5730	120	4
818-2A	40	67	TCA Inlet	6.2	1115	455	45	55	105	2000	1545	5275	95	9
			TCA Outlet	5.45	1140	440	45	60	205	2035	1490	5415	100	9
818-2B	39	24	TCA Inlet	6.2	1170	455	45	60	110	2215	1555	5610	110	7
			TCA Outlet	5.4	1175	445	45	60	220	2165	1515	5625	105	8
819-2A	37	94	TCA Inlet	5.55	1290	380	40	60	300	2030	1625	5725	110	6
			TCA Outlet	5.2	1415	380	40	60	705	2190	1590	6380	125	5
820-2A	37	92	TCA Inlet	5.65	1400	360	50	60	245	2005	1765	5885	115	7
			TCA Outlet	5.3	1540	365	50	60	585	2130	1780	6510	125	7

Run No.	Percent Solids Discharged	Percent Sulfite Oxidized	Sample Point	pH	Liquor Species Concentration, mg/l (ppm)								Calculated Percent Gypsum Saturation @ 50°C	Percent Error In Ionic Imbalance
					Ca^{++}	Mg^{++}	Na^{+}	K^{+}	$SO_3^{=}$	$SO_4^{=}$	Cl^{-}	Total		
TFG-2A	53	12	TCA Inlet	5.40	240	0350	62	80	7890	27820	3280	49720	35	7.7
			TCA Outlet	5.25	315	10280	63	82	7660	28650	3370	50420	45	6.4
TFG-2B	35	11	TCA Inlet	5.70	1845	700	48	39	103	1920	3880	8540	105	1.2
			TCA Outlet	5.00	1940	710	50	42	165	2170	3950	9030	120	-0.1
TFG-2C	37	11	TCA Inlet	5.85	1620	575	46	40	145	1370	3420	7220	75	2.9
			TCA Outlet	5.30	1735	575	46	41	180	1750	3440	7770	100	0.7
TFG-2D	39	11	TCA Inlet	5.85	1395	465	44	55	89	1800	2550	6400	95	0.3
			TCA Outlet	5.40	1415	470	43	56	165	1925	2540	6610	105	-1.3
TFG-2E	40	14	TCA Inlet	5.70	1145	470	57	64	110	1155	2535	5540	55	2.7
			TCA Outlet	5.10	1185	490	59	64	235	1390	2540	5960	70	0.0
TFG-2F	38	18	TCA Inlet	5.70	1635	565	74	71	80	1870	3320	7610	100	-0.4
			TCA Outlet	5.20	1675	610	80	64	165	1925	3500	8020	105	-1.5

APPENDIX K

FIFTH TVA INTERIM REPORT OF CORROSION STUDIES: EPA ALKALI SCRUBBING TEST FACILITY

by

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March 1979

EPA ALKALI-SCRUBBING TEST FACILITY--SHAWNEE STEAM PLANT

FIFTH INTERIM REPORT OF CORROSION STUDIES

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Summary

The fifth series of corrosion tests was conducted in the EPA alkali-scrubbing test facility at the Shawnee Steam Plant during the period October 20, 1976, to February 27, 1978. Test specimens of 15 alloys and 5 fiberglass-reinforced plastics (FRPs) were exposed at several test locations in the venturi/spray tower and Turbulent Contact Absorber (TCA) systems. In general, corrosion of test specimens appeared to be slightly less in the fifth series than in previous series of tests. However, several of the alloys that were less resistant to corrosion in previous tests were not included in the fifth series of tests.

Corrosion was negligible in the inlet flue gas duct where the gas temperature remained above the dew point. In areas where water (or slurry) provided a wet-dry interface, there was appreciable corrosion of Cor-Ten A and mild steel. Localized attack of Type 316L stainless steel occurred under deposits of solids.

Because of corrosion and/or erosion, the Type 316L shell (housing) for the cavity above the venturi needs major repair, preferably replacement. The bull nozzle requires repairs and/or replacement occasionally; the erosion-corrosion rate is approximately 185 mils per year. Major repair is needed for the guide vanes and equipment supporting the adjustable plug which controls pressure drop through the venturi. The Type 316L adjustable plug has been in service since 1972 and shows little evidence of wear. Blisters and sagging due to adhesion losses are prominent in the neoprene lining of the flooded elbow.

Minor damage to the neoprene lining in both towers was inflicted while installing, adjusting, and removing hardware. The fourth interim report mentioned a few blisters in the lining at the top of the spray tower. Some of these blisters have increased in size and new ones have

developed, but they have done little damage to the lining because they were formed between layers of neoprene and do not penetrate to the carbon steel shell.

The Type 316L, chevron-type, open-vane, three-pass, mist eliminator units have been in service 18,000 or more operating hours. Little general corrosion was detected, but pitting occurred on the edges of the vanes in the spray tower. Some pits penetrated 185 mils into the width of the vane. The performance of the unit is still acceptable. Pitting was less pronounced on a similar unit in the TCA system.

Deposits of solids on hardware in the towers promote pitting. Type 316L stainless steel is more resistant to pitting than Type 304L. The three-component spiral nozzles with diffusers of Haynes Stellite Alloy No. 6 are considerably more durable in the spray tower service than the original one-piece, spiral nozzle of Type 316 stainless steel. In the TCA tower, four Type 316 nozzles disperse the process slurry. These nozzles have grooves and pits but continue to give good service after 26,000 hours of operation. The corrosion rates for most alloys tested in the towers were less than 1 mil per year. However, localized attack of Type 304L stainless steel was severe and corrosion rates for Cor-Ten A and mild steel ranged from 47 to 185 mils per year.

Pitting occurred under deposits of solids in the ducts between the tower and the induced-draft fan of each scrubber system. In the duct between the reheater and the induced-draft fan of the venturi/spray tower system, pits were 50 to 78 mils deep. In the corresponding duct of the TCA system, pits were only 20 to 30 mils deep. The hardness of the deposited solids in the TCA duct indicates that, at some time during the test period, the temperature of the scrubbed gas in the TCA duct was higher than that in the spray tower duct. (The reported temperatures for the two ducts, however, do not confirm this.) It is believed that less condensate in the TCA duct (because of the higher temperature) accounts for less pitting of the TCA duct.

The induced-draft fan in the venturi/spray tower system has more nicks and bends on the blades and shrouds than the fan for the TCA system. The loss in thickness of fan blades since February 1973 was 6 and 3 mils (approx. 1 and 0.5 mil/yr) for the venturi/spray tower and TCA fans, respectively. The area on the venturi/spray tower fan that cracked previously and had been repaired twice appeared to be sound during the current inspection. Stressed specimens exposed in the fan housing did not crack during 2-1/2 years of exposure.

In general, Type 316 stainless steel pipe has given good service. The loss of corrosion resistance (obvious in the most severe conditions) due to cold-working (threading, etc.) can be restored by solution-annealing after fabrication. Neoprene-lined carbon steel pipe showed no evidence of deterioration during the first few years of service. In recent years, blisters have been formed by fluid that collects between the lining and the carbon steel. The process slurry corrodes unprotected carbon steel. Limited tests have been made of plastic pipe for handling process slurry. Freezing slurry caused breakage of the test pipe, and this resulted in only comparatively short exposure periods. There was no evidence of chemical attack or appreciable erosion of the pipe sections.

Some areas of the Hayward strainers were eroded by the slurry; these areas were repaired occasionally by deposition of weld metal. Trouble has been experienced with opening and closing knife-gate valves after the gates have been in one position for an extended period of operation. Deposited solids bond the gate to adjacent parts of the valve, and when force is applied to open or close the gate, the threads on the shaft that operates the gate are stripped.

Tests were made to show the effect (if any) of forced oxidation of process slurry and flyash content of flue gas on corrosion. Because of frequent changes in test conditions, a precise evaluation of these factors was not possible. However, it appears that forced oxidation did not appreciably alter corrosion. It was not evident from the results of these tests that variations in the flyash content of the flue gas affect corrosion rates. The pH level of the process slurry probably complicates the role of flyash with respect to the corrosion of alloys.

EPA ALKALI-SCRUBBING TEST FACILITY--SHAWNEE STEAM PLANT

FIFTH INTERIM REPORT OF CORROSION STUDIES

Introduction

The alkali-scrubbing test facility at the Tennessee Valley Authority's (TVA's) Shawnee Steam Plant is a prototype lime/limestone wet-scrubbing facility for removing sulfur dioxide and particulates from the flue gases from coal-fired boilers. The test facility was built as part of an experimental program sponsored by the Environmental Protection Agency (EPA) and TVA. TVA constructed the test facility and is responsible for its operation, maintenance, and modification. Bechtel National, Inc., the primary contractor for EPA, designed the test facility, directs the test program, and is responsible for data evaluation and technical reporting. Input to the program by the utility industry is provided through the Electric Power Research Institute.

Important parts of this experimental program have been the evaluation of various materials of construction for use in lime/limestone wet-scrubbing systems and the identification and solution of corrosion and erosion problems associated with these materials. At the request of EPA, the Process Engineering Branch of TVA's Division of Chemical Development started corrosion studies at this facility in 1972 and has since completed five series of tests. Results of the first four series of tests were reported in the first four interim reports: TVA Special Reports S-465, October 1973; S-465A, May 1974; S-470, March 1976; and S-472, April 1977.

Corrosion Tests

During the fifth series of corrosion tests (10/20/76-2/27/78), the test facility consisted of two parallel scrubber systems: a Turbulent Contact Absorber (TCA) system and a venturi/spray tower system. Each scrubber system was designed to treat about 30,000 acfm of flue gas at 260° to 330°F. During the test period, both scrubbers received flue gas from the No. 10 boiler at Shawnee Steam Plant. The flue gas from this boiler contained 2000 to 4000 ppm of sulfur dioxide and 0.01 to 7 grains of particulate per standard cubic foot. For the corrosion tests, specimens of 15 alloys and 5 fiberglass-reinforced plastics (FRPs) were exposed in each of the scrubber systems at the test locations shown in Figures 1 and 2. These figures also show some of the features of the scrubber systems. Detailed descriptions of the systems were included in the previous interim reports.

During the test period, the onsite inspection engineer made periodic inspections of the scrubber systems and test specimens. Personnel from TVA's Corrosion Laboratory also made limited inspections of the systems and specimens from April 10 to 14, 1978. The onsite inspection engineer made reports on his inspections and much of the information in this fifth interim report was taken from those reports. Operating conditions listed in this interim report were taken from Bechtel's monthly reports which list the steady-state operating conditions.

Test Facility Operation

During most of the test period, both scrubber systems were operated simultaneously. Operational data for the test period and accumulative operational data since each system was placed in operation are included in the following tabulation:

Fifth series	Venturi/spray tower	TCA
Test period	10/20/76-2/27/78	11/24/76-1/24/78
Run Nos., inclusive	VFG-1B - 867-1A	701-2A - 820-2A
Operating hours	8,166	7,632
Idle hours	3,714	2,592
Accumulative Operating Time Since Startup		
Period	9/5/72-4/10/78[a]	8/17/72-4/12/78[a]
Hours	32,370	33,845
Days	1,307	1,410

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[a] Date unit was shut down for inspection in preparation for fifth interim report.

Test Specimens

The specimens listed in Tables I, II, and III were tested in the venturi/spray tower and TCA scrubber systems at the test locations shown in Figures 1 and 2, respectively. All alloys were not exposed at all test locations, and FRP specimens were only included on spool assemblies that were exposed at test locations where temperature was not expected to significantly affect the plastic-base materials. Specimens tested on the spool and probe assemblies shown in Figure 3 were prepared as 2-inch-diameter disks. One rack of U-shaped stressed specimens of six alloys (Fig. 3) was exposed in the inlet cavity of the induced-draft fan of each scrubber system. The composition of each of these alloys is given in Table IV.

Exposure Periods

In the fifth series of tests, the longest exposure period for specimens in the venturi/spray tower system was 8166 operating hours (Table I) and the shortest exposure period was 70 hours (Table II). The longest and shortest exposure periods for specimens exposed in the TCA system were 7632 and 1500 hours (Table III). Usually, the reason for different exposure periods was to evaluate the effect of altered operating conditions on corrosion of the test specimens. Operating conditions in the scrubber systems are frequently changed to study process technology and process chemistry. To comply with the projected schedule for facility operation, removal of test specimens after special runs was not always practical. Consequently, test specimens that were to be exposed only during runs under special operating conditions and then removed sometimes remained in the system considerably longer and under altered operating conditions. Obviously, this interfered with the evaluation of isolated conditions with respect to corrosion.

Three different spools of specimens were tested (one at a time) below the venturi at test location 1011 (Fig. 1 and Table II). The exposure periods were 5547, 70, and 2226 hours. This is the most severe test location in the experimental scrubber facility because of erosion and corrosion. U-shaped stressed specimens were exposed in the inlet cavity of each induced-draft fan for approximately 2-1/2 years.

Exposure Conditions

The coal used in the No. 10 boiler at Shawnee Steam Plant during the fifth series of corrosion tests contained an average of 3.3% (2.4-3.8%) by weight sulfur and 15.0% (12.0-15.8%) by weight flyash.

Definite information is not available as to the chloride content of the coal. However, the analyses of nine random samples of coal used at the steam plant (probably in all units) from December 1975 to July 1977 indicated that the chloride concentration ranged from 0.01 to 0.37% by weight. Also, the chloride concentration of four monthly (months not identified) composite samples of coal used at the steam plant ranged from 0.02 to 0.18% by weight. The chloride content of coal is important with respect to corrosion in the wet-scrubber systems, especially if the slurry pH is low.

The temperature of the inlet flue gas was in the range of 260° to 330°F. The temperature of the exhaust gas (after being scrubbed and reheated) was in the range of 235° to 265°F. The analyses of the gases at the inlet and outlet of the scrubber systems were as follows:

Component	Flue gas in	Scrubbed gas out
SO_2, %	0.2-0.4	0.02-0.10
CO_2, %[a]	10-18	11-19
O_2, %	3.5-12	4.5-12.5
H_2O, %[a]	8-15	6-16
HCl, %[a]	0.01	-
N_2, %[a]	74	69
Flyash, gr/stdft^3[b]	0.01-7	0.005-0.04

[a] Estimated.

[b] Values include operation with and without electrostatic precipitator.

Properties of the liquor in the effluent and clarifier tanks of the two scrubber systems are included in Tables I and III.

Preparation and Mounting of Specimens

Preparation

Disk-type specimens of alloys and FRPs were 2 inches in diameter and had a 23/64-inch hole drilled through the center for assembly on a spool-type or probe-type mount (Fig. 3). Teflon insulators were used to prevent contact of dissimilar metals. Disk-type specimens of the five FRPs were made from sheets about 1/8 inch thick, and the machined edges of the disks were sealed with resin as recommended by the manufacturers of the FRPs. Disk-type specimens of the 15 alloys tested were made from metal stock about 1/8 inch thick that had been welded according to the recommendations of the manufacturer of the respective alloy. After these welds were made, the alloys were allowed to cool slowly in air to simulate cooling of large equipment after it has been welded during construction or repair. After the alloys were welded and cooled, the 2-inch-diameter disks were prepared so that the weld was across the diameter of the disk. The disks were smoothed by machining.

Stressed specimens were made by forming a strip of alloy (about 1/8 by 1 by 5-1/2 in.) into a U shape and drilling a 1/2-inch hole in each end of the strip to accommodate a 1/4-inch bolt (Type 316 stainless steel). This bolt, which was fitted with a Teflon insulator, was used to apply static stress to the specimen in a rack as shown in Figure 3. Table IV gives the composition of the alloys tested.

Mounting

Disk-type specimens were mounted in the scrubber systems by one of four methods. At some test locations, spool assemblies were bolted to permanent brackets that had been welded in place. In other test locations, spool assemblies were bolted to an existing pipe by means of a band-type clamp (Fig. 3). In tanks, spools were suspended by a 1/8-inch strip or 3-inch-diameter pipe bolted to the top of the tank. Sleeves of soft butyl rubber (3/8 in. thick and 6 in. long) were used on these supports to prevent abrasive damage to the Flakeline coating or neoprene lining of the tank walls. In vessels or ducts, probe-type assemblies were installed through the wall by means of a 2-inch pipe coupling and companion plug that supported the assembly. Stressed specimens were installed by bolting the rack to a bracket that had been welded at the desired location.

Results of Plant Inspections and Corrosion Tests

During the fifth series of tests, periodic inspections were made of the scrubber systems and the test specimens. All corrosion rates were calculated on the basis of weight loss of specimens assuming that the loss occurred during the period of operation of the scrubber system rather than during the overall exposure period. Low corrosion rates determined by weight loss are omitted for test specimens that had significant penetration by crevice corrosion and/or pitting.

Durometer A hardness values of rubber linings on equipment were measured with a Shore instrument, Type A2, ASTM 2240. Initial hardness values of equipment linings were not determined, so in previous reports, hardness values listed in the vendor's specifications were used as reference values. In this report, however, the hardness values are compared with those determined during previous inspections (Table V).

Inlet Ducts for Flue Gas

The flue gas entering the scrubber test facility contained carbon dioxide, hydrogen chloride, moisture, nitrogen, oxygen, sulfur dioxide, and flyash at temperatures of 260° to 330°F. The composition of the gas varied with the source of coal. During a period of limited supply of coal in early 1978, changes in the source of supply were necessary to maintain operation of the generating facilities.

Carbon Steel Ducts: The carbon steel inlet gas duct for the TCA system was observed at one location in a horizontal section and appeared to be in good condition. Only slight scaling and minor deposits of dust were noted in the main section of the duct which is insulated. However, inside an uninsulated flanged joint, a tightly adhering scale had formed on the surface of the metal. This scale evidently offered some protection by reducing the quantity of condensate that collected on the cool surface of the metal (heat lost from bare flanges). This scale, however, does not eliminate condensate, especially during cold weather.

Stainless Steel Ducts: A section of Type 316L stainless steel duct is located between the carbon steel inlet duct and the scrubber in each system. The Type 316L duct in the venturi/spray tower system had localized attack where the hinges of a small door were welded to the duct at test location 1002 (Fig. 1). This failure allowed intake of air through the opening. The duct wall at the bottom of the door is 0.118 inch thick. Further discussion of the Type 316L duct in the venturi/spray tower system is included in the "Venturi Unit, Inlet Gas Duct" paragraph.

In the TCA system, the Type 316L stainless steel duct had deposits of solids at three locations--on an emergency cooling spray header (minor deposit), around the soot blower nozzle (unusually thick deposit), and at the wet-dry interface produced by the cooling sprays which are located near the entrance to the absorption tower. A leaking valve in the emergency spray system (sprays are located directly above the soot blower nozzle) caused the accumulation of solids on the spray header and around the soot blower.

Specimens Tested in Inlet Gas Duct: If the temperature of the inlet flue gas is maintained above the dew point, corrosion of Cor-Ten A and mild steel is negligible during operation, but corrosion occurs during idle periods. In the fourth series of tests, the corrosion rates for Cor-Ten A and mild steel at test location 1002 in the venturi/spray tower system were 42 and 28 mils per year, respectively; at test location 2002 in the TCA system, the corrosion rate for each of these alloys was only 3 mils per year. The reason that the corrosion rates were higher than expected was not obvious at that time. In the fifth series of tests, the corrosion rates for these two alloys were again unexpectedly high. Specimens of Cor-Ten A and mild steel at test location 1002 were perforated and had respective corrosion rates greater than 33 and greater than 45 mils per year. At test location 2002, the respective corrosion rates for Cor-Ten A and mild steel were 14 and 15 mils per year and both specimens had crevice corrosion. During an inspection after the fifth series of corrosion tests, the automatic shutoff valves to the emergency sprays were leaking (greater leak in venturi/spray tower system) and manually operated valves upstream from the automatic valves had to be closed to stop the leak. In the fifth series of tests, corrosion rates for the other alloys exposed at test locations 1002 and 2002 were 1 mil per year or less (Tables I and III).

Soot Blowers: The soot blowers are used to remove solids that are deposited on the duct walls at the wet-dry interface. Various schedules for use of these soot blowers have demonstrated that operating the soot blowers from one to three times per day is adequate to remove the solids under present operating conditions. These units are in good condition and require very little maintenance.

Venturi Unit

Shell: The Type 316L shell (housing) that forms the cavity above the adjustable plug of the venturi unit has been patched several times because of corrosion and/or erosion and is in need of major repair. The uppermost plate was originally flat but has long since become concave from carrying some of the weight of the inlet gas duct that enters from above.

Inlet Gas Duct: Sections of the 3/16-inch-thick inlet gas duct of Type 316L stainless steel that extends inside the cavity above the venturi have been removed as failure occurred during the last 2 years and only a small section of duct remains inside the cavity. Failure of this duct was caused by chloride stress-corrosion cracking which was discussed in the fourth interim report. Loss of the duct section that extended inside the cavity evidently has not affected performance of the venturi.

Bull Nozzle: Erosion-corrosion of the 5-inch-diameter, Type 316 stainless steel bull nozzle by the process slurry was severe (approx. 185 mils/yr). Two nozzles have been used alternately in this service. The original nozzle (a smooth-bend, ninety-degree elbow) was used 265 operating days before repairs were required. Subsequent periods of service between repairs have been shorter. The second nozzle was fabricated by welding together short sections of pipe to build a ninety-degree elbow.

Adjustable Plug and Components: The Type 316L stainless steel adjustable plug showed little evidence of erosion or corrosion even though the bull nozzle discharges process slurry onto the top of the plug. The adjustable plug controls the pressure drop across the venturi. No repairs have been required for the plug which has been in service since 1972.

Four equally spaced guide vanes for the 4-inch-diameter shaft that support and operate the adjustable plug are located immediately below the plug in the venturi throat (Fig. 4). The support shaft, shroud for the shaft, flanges, adjustable guide vanes, and shields for the guide vanes are constructed of either Type 316 or Type 316L stainless steel. The plastic block-type bearings located between the adjustable guide vanes and the support shaft are constructed of Rulon Type LD, a modified fluorocarbon. As of April 1978, all the metal components in this area had experienced erosion-corrosion and/or pitting attack and the Rulon bearings were eroded appreciably.

Erosion-corrosion penetrated through the support shaft for the adjustable plug in September 1978. The penetration rate was 31 mils per year based on 3.9 years of operating time. The shaft and guide vanes were replaced in October with new components constructed of Type 316L stainless steel.

Specimens Tested Below Venturi: Three identical spools of specimens were exposed during different periods at test location 1011 in the fifth series of tests. Because of the high velocity of the gas-slurry mixture in normal operation, the conditions are more severe at test location 1011 than at any other test location in the two scrubber systems. Exposure periods are usually shorter at this location for this reason. In the current tests, the three spools were identified as 1011, 1011A, and 1011B.

Test conditions were similar and the results were consistent for spools 1011 and 1011B in the current series of tests except for Zirconium 702 which had a corrosion rate greater than 75 mils per year at test location 1011 and only 6 mils per year at test location 1011B (Table II). A different location of the test specimen on the spool and channeling of the gas-slurry mixture probably account for the difference in corrosion rates for Zirconium 702. Cor-Ten A and mild steel were attacked at extremely high rates. The rates for the other alloys ranged from 1 mil per year for Haynes 6B to greater than 150 mils per year for Type 304L. There was little difference in the resistance of stainless steel Types 316L (2.6% Mo) and 317L (3.2% Mo), and crevice corrosion was common on both alloys.

In general, the erosion-corrosion rates for specimens common to all previous series of tests at location 1011 were greater than those in the fifth series except for Cor-Ten A and mild steel which were attacked at excessively high rates in each series of tests.

Conditions were different for exposure of spool 1011A during run VFG-1Q which lasted only 70 operating hours. Water was used in the venturi instead of lime or limestone slurry. Run VFG-1Q was made to determine the particulate removal efficiency of the spray tower alone when using lime slurry to scrub flue gas that contained only a small amount of flyash (about 0.15 gr/stdft^3, referred to at the test facility as "flyash-free" gas). The plan was to remove as little particulate as possible from the gas at the venturi. To protect the neoprene lining upstream from the spray tower from damage by the 265° to 330°F flue gas, 15 gpm of water was dispersed by the humidification sprays into the inlet duct to cool the gas during the first 2 days. However, the water sprays plugged and the gas temperature in the crossover duct (flooded elbow in normal operation) exceeded 200°F and the unit shut down automatically. After several of these shutdowns, additional cooling water was added through one of the tangential sprays in the cavity above the venturi (total cooling water rate was 40 gpm) for the remainder of the 70-hour test period. The flue gas flow rate was 35,000 acfm and its particulate mass loading was 0.15 grain per standard cubic foot. The adjustable plug was completely open which gave a pressure differential across the venturi of 2.5 inches of water compared with 9 inches in normal operation.

The data in Table II for alloys Carpenter 20Cb-3; Haynes 6B; Jessop 700; Multimet; Nitronic 50; stainless steel Types 304L, 316L, and 317L; and Zirconium 702 show that conditions at test location 1011 were more severe when the flue gas was cooled only with water than when it was cooled with process lime/limestone slurry. However, Hastelloy alloys G and C-276 and Inconel 625 were attacked at lower rates when the flue gas was cooled with only water. Cor-Ten A and mild steel showed poor resistance in all tests; both had corrosion rates ranging from greater than 1000 to greater than 3290 mils per year in the three tests. In the absence of alkaline slurry, the pH of the cooling water dropped to a low value during the 70-hour test period. (The pH was not determined but was probably below 2.0 based on conditions encountered in previous work at Colbert Steam Plant.) Also, the temperature was above normal because less cooling fluid was used and at times water sprays became plugged.

Flooded Elbow: A thick, hard scale covered part of the neoprene lining in the flooded elbow. In previous reports, loss of adhesion and sagging of the neoprene lining were noted in areas mainly overhead and on the north wall. The overhead area was sealed with scale which was not disturbed. The scale thickness that can be supported without damage to the lining is in question, especially in areas where some loss of adhesion has occurred. During the inspection for the fifth series of tests, several large blisters were seen on the north wall (Fig. 5). Some of the blisters appeared to have been punctured, possibly to release pressure and alleviate further loss of adhesion.

There was no evidence of corrosion on two stainless steel probes in the duct; apparently they had been in service only a short time.

Scrubber Towers

Neoprene Lining: The hardness values determined for the neoprene linings are given in Table V. With the exception of localized areas, the tower linings were in good condition. Minor damage has occurred to the lining in both towers, mainly in the areas of the manways. The damage occurred while installing, adjusting, and removing hardware.

At the time of inspection, the walls in the TCA tower were clean from the bottom grid to the mist eliminator. The undersprays kept the area clean below the mist eliminator, and movement of the spheres cleaned the areas between the grids. The lining was peeling at a lap joint on a protruding corner of a window jam located a few inches above the bottom grid.

A few blisters in the neoprene lining above the mist eliminator of the venturi/spray tower system were mentioned in the fourth interim report. The number of blisters has increased and some of the older blisters (first detected in Jan. 1976--then less than 1 in. in dia.) have increased in size. The 1/4-inch-thick neoprene sheet consists of several layers. Fluid collected between the uppermost layers to form the blisters and did not penetrate to the carbon steel shell. Deterioration of this area of the liner above the mist eliminator was minor as of April 1978. However, a blister in the fourth manway door measured 6-1/2 by 2-1/4 by 1-1/2 inches. Its depth or origin (whether between plies or adjacent to the steel) was not determined.

A thick, hard scale covered some areas of the spray tower. Unless care is exercised in prying the scale loose, especially if sharp tools are used, the lining could be damaged. Changes in the modes of operation affect the amount of scale in the equipment.

Grids: The four grids in the TCA tower are made of Type 316 stainless steel, 3/8-inch-diameter rods. These grids have been in service about 4-1/2 years (installed Oct. 1973). Two rods of Type 409 stainless steel were installed in the bottom grid by error; they were less resistant to corrosion than the Type 316 rods and have been replaced with rods of Type 316. The three bottom grids support TCA spheres. Movement of the spheres causes wear of the rods that support them. The wear usually occurs in two planes on the top half of the grid rods; however, some of the rods have been turned and have more than two worn planes. Only a few rods were measured. The greatest loss in diameter of Type 316 rods was 23 mils, and this occurred on rods in the bottom two grids (G-1 and G-2). Spheres are not installed on the top grid (G-4) which showed a loss in diameter of only 3 mils. It is assumed that the 3-mil loss was due to corrosion and the 23-mil loss was due to erosion-corrosion. Pitting of the rods and of the Type 316 rod-support frame also occurred. The depths of pits measured were 4 to 20 mils. Crevice corrosion was common on the grid rods under and adjacent to the rubber grommets on the ends.

Spheres: Several combinations of TCA sphere types and bed depths were employed during the fifth corrosion test period. The types of spheres used were thermal plastic rubber (TPR, both 5- and 6-g), high-density polyethylene (HDPE, 5-g), and acrylonitrile foam spheres (6-g). After considerable wear on the surface, the TRP and HDPE spheres either split in half at the mold seam or dimpled which permitted them to squeeze through the space between the grid bars. The acrylonitrile foam spheres had an initial shrinkage rate of 6 to 12% (0.1-0.2 in.) of the diameter during the first 1000 hours, but afterwards the shrinkage rate decreased to 3.1% (0.05 in.) per 1000 hours for the remainder of 6700 hours of service. Some of the spheres also migrated from one grid to another.

Stationary Packing: Forty-six inches of stationary plastic packing (manufactured by the Ceilcote Co.) was used instead of spheres to increase contact of gas and scrubber liquor during a 352-hour period. Minor scale formation was observed along the edges of some of the packing plates.

Mist Eliminators: The mist eliminator in each scrubber system is a chevron-type, open-vane, three-pass unit constructed of Type 316L stainless steel. A new mist eliminator was installed in the spray tower on January 30, 1975, and has been in service approximately 18,500 operating hours. A new mist eliminator was installed in the TCA tower on July 19, 1975, and has been in service about 18,000 operating hours. During these service periods, general corrosion of the vanes was negligible to 1 mil per year. Originally, the vanes were 62 mils thick; now they are 60 to 62 mils thick. However, pitting occurred on the edges of the vanes in the spray tower. Some pits penetrated 65 to 185 mils from the edge into the width of the vanes (see Fig. 6). Pitting was much less pronounced on the mist eliminator of the TCA system. The oversprays and undersprays used currently in both scrubber systems have improved cleanliness of the mist eliminators greatly compared with the plugged conditions experienced during the original operation of the scrubber systems. The vanes are distorted on the top because of impact from heavy chunks of solids that fall from the scrubbed gas outlet duct. However, performance of the unit is still acceptable. The installation of a heavy-duty grid a few inches above the mist eliminators would provide some protection for the mist eliminators.

Tables I and III show that the specimens of Cor-Ten A and mild steel exposed near the mist eliminator at test location 2004 in the TCA scrubber (Fig. 2) were corroded more than those at the corresponding test location, 1004, in the spray tower (Fig. 1). The Type 316L specimens exposed at 2004 and 1004 were corroded about the same at each test location and much less than Cor-Ten A and mild steel. Apparently, exposure conditions were only slightly more severe at 2004 than at 1004. The difference in resistance to pitting attack by the two mist eliminators was probably due to differences in composition of the Type 316L stocks and history of treatment before and/or after fabrication of the mist eliminators.

Headers, Support Brackets, and Door Deflector Plates: In the towers, the spray headers, support brackets, and deflector plates for the manway doors were specified to be constructed of Type 316 stainless steel. Previous reports have pointed out that some sections of the spray header have been identified as Type 304 stainless steel. Pitting of both alloys has occurred in the tower; Type 304 is less resistant to pitting than Type 316. Deposits of solids on these alloys inside the towers promote pitting. The depth of pits on headers and support brackets were not measured during the current inspection. Pits on the Type 316 stainless steel deflector plates inside the manway doors of the venturi/spray tower system were measured and ranged from 12 to 78 mils deep (Fig. 7).

Slurry Spray Nozzles: The main process slurry spray nozzles in the spray tower are located at four elevations. During the fifth series of tests, the process slurry that circulated through the spray tower contained 7 to 17% by weight of solids. The original spray nozzles were one-piece spiral nozzles (Bete TF48FCN) made of Type 316 stainless steel. The replacement three-component spiral nozzles (Bete ST48FCN) with diffusers of Haynes Stellite Alloy No. 6 (other components of Type 316 stainless steel) are considerably more durable than the original nozzles. A set of 27 nozzles with Stellite Alloy No. 6 diffusers had a service life of 17,250 operating hours (3/15/74-12/6/76). Stellite Alloy No. 6 contains 25% chromium, 5% tungsten, 1% carbon, and 69% cobalt. Because the stainless steel nipples on the slurry headers were corroded excessively, a few of the nozzles became loose and were lost. The number of nozzles that were lost could have been reduced by solution-annealing the cold-worked nipples after they were threaded.

In the TCA tower, process slurry containing 7 to 16% by weight of solids was dispersed through four Spraco 1969F nozzles (full-cone, free-flowing nozzles made of Type 316 stainless steel) located in quadrants above grid G-4. Deep grooves had eroded in the swirl vanes and some pitting was noted. The diameter of the nozzle orifices increased an average of 48 mils during approximately 10,800 hours (approx. 450 days) of operation since the end of the fourth series of tests. As of April 12, 1978, this set of nozzles had been in service approximately 26,000 operating hours and continued to give good service.

Rupture Disks: Rupture disks were provided in the scrubber towers to protect the neoprene linings (and possibly other equipment) from damage due to high vacuum that the induced-draft fans might produce should the inlet gas duct become plugged. The disks were designed to flex inward and be pierced by sharp, stationary instruments. The ruptured disks would then admit outside air to decrease the vacuum. Even though pressures have been low at times, none of the disks have ruptured in either scrubber tower because the accumulation of solids on the inside surface of the disks prevents their flexing.

Miscellaneous: A frame constructed of 2- by 4-inch wood (species not identified) is located in an observation port immediately above the third grid in the TCA tower. The frame, which was installed to remedy an operational problem, has been exposed to the lime/limestone slurry spray for several years and still appears to be sound. Slight wear has occurred on the hard annular growth rings and more wear has occurred on the soft rings.

Specimens Tested in Towers: Test locations in the towers from the bottom upward are identified in Figures 1 and 2 by the numbers 1006, 1005, and 1004 in the spray tower and 2006, 2005, and 2004 in the TCA tower. As shown in Tables I and III, corrosion rates were negligible to less than 1 mil per year for the following alloys tested in both towers: AL 6X, Hastelloy C-276, Hastelloy G, Inconel 625, Jessop 700, Miltimet, and Zirconium 702. Comparative severity of conditions at the test locations is shown by the corrosion rates of Cor-Ten A and mild steel which were the least resistant alloys tested. Localized attack of Type 304L stainless steel was severe. The greatest corrosion of specimens occurred at test locations 1005 and 2005. The respective corrosion rates for Cor-Ten A and mild steel were 105 and 185 mils per year in the spray tower and 47 and 96 mils per year with localized attack in the TCA tower. The lowest corrosion rates, respectively, for Cor-Ten A and mild steel were 13 and 14 mils per year at 2006 in the TCA tower and 22 and 29 mils per year at 1004 in the spray tower. In this series of corrosion tests, localized attack of Cor-Ten A and mild steel did not occur in the spray tower but did occur in the TCA tower except at location 2006. Note that test location 1006 in the spray tower has been changed since the fourth interim report was issued; a trapout tray has been installed in the tower (Fig. 1) and test location 1006 is now located below the trapout tray.

Exhaust System

Duct Between Tower and Reheater: The Type 316L stainless steel duct between the neoprene-lined tower and the reheater in each scrubber (Figs. 1 and 2) was pitted and contained a tightly adhering solids deposit. The exterior of the Type 316 corrugated expansion joint located between the tower and the reheater appeared to be in good condition.

Equipment for Reheating Scrubbed Gases: Scrubbed flue gases are reheated to 235° to 265°F by external oil-fired heaters. Originally, in-line reheaters were used, but they were not satisfactory because of frequent flameouts. Hot combustion gases from the external heaters mix with and reheat the scrubbed gases. The ceramic linings in the reheater equipment were in good condition as of April 12, 1978. A patch had been welded on the carbon steel shell at the bottom of the old in-line reheater for the TCA system.

Duct Between Reheater and Induced-Draft Fan: In each scrubber system, the duct between the reheater and the induced-draft fan contained a heavy deposit of solids. The deposit in the venturi/spray tower duct appeared to have been a thick mud-like material that was flowing slowly down the wall when solidification occurred (Fig. 8). The deposit in the TCA duct appeared to have been heated considerably above the normal operating temperature. This tightly adhering scale was difficult to remove from the Type 316 stainless steel duct. A small area 2 feet above the cavity of the old in-line reheater was steam cleaned in each duct for inspection. Pits that were measured in this area of the venturi/spray tower duct were 50 to 78 mils deep and those in a corresponding area of the TCA duct were 20 to 30 mils deep. Comparatively small, shallow pits were found in both ducts several feet downstream.

In each scrubber system, the ductwork downstream from the reheater is divided. Each branch of the duct contains a fan damper. The branches of the duct terminate at the inlet ports of the induced-draft fan. This section is constructed of Type 316L stainless steel. Moderate corrosion was evident on the divider surface. The corrosion was greater on the welds and in the corners of the unit. Solids deposited on the TCA divider were harder than those on the venturi/spray tower divider.

Dampers: The damper consists of a section containing seven louvers in each branch of the divided gas duct. All louvers in the TCA damper were in service during operation, but only three louvers on each side of the divider were being used in the venturi/spray tower damper. By closing the other louvers, the flow of gas through the system could be controlled as desired. The active louvers in both scrubber systems were coated with a thin deposit of solids. The dampers were in good condition.

Induced-Draft Fans: No changes of importance were noted in the condition of the induced-draft fan in either scrubber system since the fourth series of tests was completed. The fan in the TCA system appears to be in slightly better condition than the fan in the venturi/spray tower system which has more nicks and bends on the blades and shrouds. The area where cracks have been repaired twice (third and fourth interim reports) was checked with penetrant dye and appeared to be sound. Frequent inspection of this fan should be continued.

Measurements have been made (with calipers) of the thickness of blades and shrouds of both induced-draft fans after each series of corrosion tests. The first series ended in February 1973. As of April 12, 1978, the average losses in thickness of the shrouds and fan blades for the venturi/spray tower fan were 1 and 6 mils, respectively. For corresponding components in the TCA fan, the average losses were 0 and 3 mils.

Stressed Test Specimens: In July 1975, a rack of U-shaped stressed specimens was installed in the inlet cavity to each fan (test locations 1016 and 2016, Figs. 1, 2, and 3). Prior to this date, a crack had occurred in the Type 316L induced-draft fan in the venturi/spray tower system. The purpose of the tests was to determine if several alloys would crack under static stresses in the scrubber environment. As of January 1978, after about 2-1/2 years of exposure, none of the specimens had cracked. This exposure period was similar in length to the service period of the venturi/spray tower fan when the first crack was noted. Apparently, cyclic stresses produced by vibration of equipment were factors in cracking the fan. The following tabulation lists the alloys tested in the inlet cavity to each fan and gives the corrosion rates on the basis of weight loss.

Alloy	Corrosion rate, mils/yr[a]	
	Venturi/spray tower	TCA
AL 6X	1	Negligible
Inconel 625	< 1	Negligible
Nitronic 50	1[b, c]	Negligible
Type 316 stainless steel	1	< 1
Type 316L stainless steel (2.3% Mo)	1[b, c]	Negligible
Type 317L stainless steel (3.2% Mo)	1[b, c]	Negligible

[a] Negligible indicates corrosion rate was less than 0.05 mil/yr.

[b] Crevice corrosion.

[c] Minute pits.

Expansion Joint and Transition Section: The Type 316L stainless steel rectangular expansion joint located between the induced-draft fan and the transition section (from rectangular to cylindrical) in each system has been repaired several times. Narrow cracks that occurred in the joints have been sealed by applying a weld bead of Type 316L. Larger corroded areas have been patched by welding a strip of Type 316L over the failed area. It is believed that a corrugated, cylindrical expansion joint would be more durable in this application than the rectangular expansion joint now in use because the number of welded joints would be reduced. This change could be simplified by locating the transition section between the induced-draft fan and the expansion joint. The corrosion resistance of Type 316L equipment in this service could be increased by solution-annealing each unit after fabrication. A port in the transition section of the venturi/spray tower system was opened (not used in previous inspections) for the current inspection. Corrosion was noted on the shields (Fig. 9) that were provided to prevent accumulation of solids inside the convolutions of the expansion joint. Apparently, corrosion of this area is due mainly to accumulation of condensate. The quantity of condensate produced during normal operation could be decreased by insulating the expansion joint and transition section.

Disk-Type Specimens Tested in Exhaust Systems: Disk-type specimens were exposed below and above the induced-draft fan at test locations 1014 and 1015 in the venturi/spray tower system (Fig. 1) and at test locations 2014 and 2015 in the TCA system (Fig. 2). The disk-type specimens were mounted at the center of the exhaust stack or duct with the faces of the disks in a vertical position. The temperature of the reheated gas in these areas is usually 235° to 265°F. Localized corrosion of specimens in the venturi/spray tower exhaust system was not appreciable, about 1 mil per year except at test location 1015 where Zirconium 702, Cor-Ten A, and mild steel were corroded at rates of 2 to 3 mils per year.

In the TCA exhaust system, localized corrosion occurred on the bottom half of most test specimens exposed at test location 2014 (below fan). The types of localized attack that occurred in the order of decreasing frequency were pits, cracks, and attack of weld metal. The only alloys that showed no localized attack were Hastelloy C-276, Carpenter 20Cb-3, Cor-Ten A, and mild steel. Their corrosion rates, in the order listed, were negligible, less than 1, 6, and 7 mils per year.

Figure 10 shows that attack of Type 316L (2.6% Mo) at test location 2014 (below TCA fan) was much more severe than at the corresponding test location (1014) in the venturi/spray tower system. The reason for this difference at similar test locations in the two exhaust systems is not obvious. Figure 11A shows cracking that occurred in the severely corroded bottom half of the Type 316L (2.6% Mo) specimen tested at location 2014. Figure 11B shows the structure of the upper half of the same test specimen where the attack was much less severe. When the specimens were received at Muscle Shoals for evaluation, specimens from test location 2014 (TCA) had considerably more solids deposited on or between them than those from test location 1014 (Figs. 12 and 13). This might not have been true throughout the test period. Also, as shown in Figures 12 and 13, the probes used to mount the specimens were bent during the test by the impact from deposits of solids that fell from the ducts above.

The accumulation of solids on and between specimens at test location 2014 was greater on the bottom half (upstream side) than on the upper half of the specimens. Thus, more moisture would be absorbed on the bottom half of the specimens, and as the moisture evaporated from the solids, a greater concentration of chlorides would accumulate on the bottom half of the specimens. Unfortunately, any possible variation in composition of the solid deposits was not investigated. However, the type of cracking that occurred in the severely corroded area of the Type 316L specimen exposed at test location 2014 is indicative of chloride stress-corrosion cracking (Fig. 11A). Stresses were implanted in the specimen when it was stenciled (cold worked) for identification.

Tanks

Effluent Hold Tanks: Effluent hold tanks D-101 and D-201 were full of process slurry needed to complete the tests that were interrupted for the general inspection. These tanks were not inspected.

Specimens Tested in Effluent Hold Tanks: Tables I and III show that the corrosion rates for most alloys tested in the effluent hold tank for each scrubber system were negligible. However, Cor-Ten A and mild steel had rates of 1 to 8 mils per year and Nitronic 50 and Type 304L stainless steel showed slight localized attack. The following plastic-base materials showed good resistance to deterioration in both tanks: Atlac 711, Bondstrand 4000, Derakane 510, and Dion 6694. The QuaCorr specimen exposed in tank D-101 also appeared to be in good condition, but the QuaCorr specimen in tank D-201 was only in fair condition (specimen was probably damaged by impact).

Recirculation Tank: During the fifth series of tests, tank D-104 was used as a collection and/or recirculation tank for process slurry used in the venturi section. During some runs, the slurry from the venturi and the slurry from the spray tower were kept separately. The neoprene lining on the tank and covering on the agitator were in good condition.

Oxidation Tank: Tank D-108 is constructed of Type 316 stainless steel. The new tank was installed in December 1976 prior to run 801-1A. The tank is equipped with a constant-speed agitator with two pitched-blade impellers. During the tests of forced oxidation in the venturi/spray tower system, air was sparged into the process slurry a few inches above the bottom of tank D-108. The octagonal sparger was made of 3-inch Type 316 stainless steel pipe in which 1/4-inch holes had been drilled. The sparger unit was connected to the air line (Type 316 stainless steel) inside the tank by a 6-inch-long spool piece. Inadvertently, the spool piece was made of Type 304 stainless steel (3-in.-dia., Sch. 10 pipe with 0.12-in. wall) which failed in less than 2500 operating hours. The corrosion rate was greater than 420 mils per year (Fig. 14A and B).

Specimens Tested in Oxidation Tank D-108: A new test location identified as 1017 (not shown in Fig. 1) was established 6 feet above the bottom in tank D-108. The original plan was to expose a spool of specimens at 1017 during consecutive runs in which air was being sparged into the slurry. The spool of specimens was to be removed from the tank when forced oxidation runs were completed. However, data related to other areas of investigation at the test facility indicated a need for more runs without forced oxidation to supply urgently needed information. Consequently, runs in the scrubber system were made occasionally without forced oxidation during the remainder of the exposure period. Therefore, tests to show the effect of forced oxidation on corrosion were not isolated as originally planned. The corrosion rates at test location 1017 were negligible for all alloys except Cor-Ten A and mild steel during an exposure period of 7211 operating hours (Table I). The corrosion rates were 11 mils per year with pits 9 mils deep for Cor-Ten A and 16 mils per year with pits 6 mils deep for mild steel. These rates are within the range of those obtained for specimens of Cor-Ten A (7-26 mils/yr) and mild steel (10-35 mils/yr) exposed in tank D-101 during the four previous series of corrosion tests without forced oxidation. Aeration of a corrosive medium usually increases the rate of attack on Cor-Ten A and mild steel. However, in this case, there was a chemical change (sulfite was converted to the less corrosive sulfate) along with the physical activity accompanying aeration.

A specimen of Type 304 stainless steel was not included in the test at 1017 for comparison with the spool piece that failed. However, in previous tests without forced oxidation, there was severe localized corrosion of Type 304 specimens at many test locations.

Tank D-109: Tank D-109 has a neoprene lining and is now used as a desupersaturation tank for the slurry from tank D-108. (Originally, D-109 was identified D-303 and was used for storage of clarified process water in the Marble-Bed scrubber system.) At the time of inspection, the tank was full of dark brown liquor that was being agitated vigorously. Hardness values of the neoprene lining near the tank top are given in Table V.

Tank D-203: The hold tank for clarified water (D-203) has a neoprene lining. The tank contained some water and was not inspected thoroughly. The lining and the agitator unit appeared to be in good condition.

Tank D-204: The recirculation tank D-204 has a neoprene lining. The lining and the neoprene cover on the agitator shaft and blades were in good condition. Structural supports and fasteners for the agitator assembly were repaired during the outage to minimize vibration.

Tank D-208: The mild steel tank D-208 was sandblasted when received at the test site prior to the application of two coats (thickness not available) of blue Polypoxy paint (an epoxy base with 2 components). The tank was put in service about April 1975. No appreciable deterioration of the coating was noted during an inspection in August 1976. However, in April 1978, the onsite inspection engineer noted that the coating had failed in some areas. Subsequent attack occurred of the unprotected A-283 carbon steel. The Type 316 stainless steel agitator assembly showed little evidence of attack.

Pumps

Process slurry is pumped mainly by centrifugal pumps manufactured by Allen-Sherman-Hoff Company. Originally, these pumps were Hydroseal pumps but were later converted to Centriseal pumps which use air instead of water for a seal. The closed-loop operation could not tolerate the quantity of water required by the Hydroseal pumps. Several Moyno pumps are also used at the scrubber facility.

Neoprene-Lined Centrifugal Pumps: Some of the pumps were not dismantled for inspection because they had been repaired recently and were performing satisfactorily. In the past, some pumps that were performing properly before dismantling developed mechanical problems after they were reassembled and placed back in service. The condition of the neoprene linings and impeller covers in the pumps that were inspected is given in the following tabulation.

	Condition of neoprene[a]		
Pump	Suction lining	Seal lining	Impeller cover
G-102	Grooved severely	Grooved severely	Grooved severely
G-105	Good condition	Good condition	Good condition
G-109	Pits 110 mils deep (old)	Good condition (new)	Good condition (new)
G-201	Damaged to depth of 1/2 inch	Damaged to depth of 3/8 inch	Damaged
G-202	Grooved moderately	Grooved severely	Grooved severely
G-205[b]	Good condition	Good condition	Good condition

[a] Hardness values are given in Table V.

[b] Portable pump used as an auxiliary unit at test facility; records are not kept to show usage.

The log for maintenance performed shows that replacement of packing and worn sleeves is the most frequent repair required for the Centriseal pumps. When the sleeve or shaft becomes worn, the life of the packing is short.

Moyno Pumps: Little wear could be detected on the neoprene stators removed from Moyno pumps. Some of these units pump against comparatively high pressure. A small amount of wear on the stator or rotor reduces performance of the pump below the minimum required in the slurry addition systems. Consequently, replacement of rotors and stators is frequently required.

Piping

Most of the original piping in the scrubber systems was either stainless steel or neoprene-lined carbon steel. Plastic piping is now being evaluated and unprotected carbon steel pipe is used sparingly.

Stainless Steel Pipe: In general, Type 316 stainless steel pipe has given good service. However, the severely cold-worked area of threaded nipples has less resistance to corrosion than the unthreaded portion. This had been demonstrated in the spray tower where spray nozzles became loose and a few of them were lost. The loss of corrosion resistance due to cold-working of the stainless steel can be restored by solution annealing. Type 316 stainless steel is annealed by heating the metal to 2000°F, maintaining that temperature for 1 hour for each inch of thickness, and then quenching the hot metal in water. This schedule for annealing does not apply to all alloys. A small furnace could be used profitably at the Shawnee test facility for annealing pipe fittings, spray nozzles, nuts, bolts, washers, and other small items that are in the cold-worked condition.

Type 316 is also susceptible to pitting in the high-chloride environment of the scrubber systems, especially in stagnant areas (under deposits of scale and/or sludge). Type 304 stainless steel is attacked at rates much greater than Type 316 under the same scrubber conditions.

Neoprene-Lined Pipe: During the first few years of service, the neoprene-lined carbon steel pipe showed no evidence of deterioration (see the second interim report, TVA Special Report S-465A, May 1974), and little or no wear occurred to the lining. Currently, blisters that range from 1/4 inch to 3 inches in diameter were found in some areas of 4-, 5-, and 6-inch-diameter neoprene-lined pipes and fittings. Since April 1977, the frequency of blistering has increased greatly. The blisters are formed by fluid that collects between the lining and the carbon steel. Some of the larger blisters appear to have been punctured, perhaps to decrease pressure and reduce their size. Figure 15 shows typical blisters in a 6-inch-diameter, neoprene-lined, slurry-feed pipe in the venturi/spray tower system (photograph taken 4/12/78).

Plastic Pipe: Three types of plastic pipe (epoxy, polybutylene, and polyvinyl chloride) have been tested in service in the scrubber systems. None of the pipe sections and fittings showed evidence of chemical attack or appreciable erosion; however, the service periods were not long enough for a good evaluation in some cases. Failure of the pipes occurred because of expansion of freezing slurry during idle periods in severely cold weather.

Carbon Steel Pipe: The process slurry corrodes unprotected carbon steel pipe, but it is used to a limited extent if more resistant piping is not available, especially when temporary modifications to the system are needed.

Strainers

In May 1975, two 6-inch Hayward strainers were installed in the discharge line near pump G-204 in the venturi/spray tower system and two 8-inch Hayward strainers were installed in the discharge line near pump G-201 in the TCA system. These are vertical-type, single-element strainers used in parallel. The strainers reduce the frequency of plugging of the spray nozzles by the slurry. The two strainers in the TCA system and one of the strainers in the venturi/spray tower system were being repaired during the outage. The south strainer in the venturi/spray tower system had been recently replaced with a new strainer. The cast steel basket support ledge in these strainers had been eroded severely and was being rebuilt by deposition of stainless steel weld metal. Erosion had occurred on the outlet throat and other areas of the unit. The Type 316 stainless steel baskets were not corroded, but they had been damaged mechanically, probably during cleaning.

One of the Elliott Type R filters (flat, dual filters) is still in use at the test facility. It is in the feed line to the two bottom headers in the spray tower. Except for moderate erosion and corrosion of the cast iron housing at each end of the baskets, the unit was in good condition. One of the two stainless steel baskets was new.

Valves

Gate Valves: Fabri-Valve knife-gate valves are located immediately upstream and downstream from the Hayward strainers to allow switching the flow of slurry from one strainer to the other. The venturi/spray tower system has 6-inch valves and the TCA system has 8-inch valves. The wetted parts of the valves are Type 316 stainless steel, and the other parts are either cast or fabricated carbon steel. During operation of the scrubbers, the valves are either completely open or closed; they are not used to throttle the slurry flow. The valves in the TCA system were inspected and appeared to be in good condition. There has been some difficulty in opening and closing the valves after the gates have been in one position for an extended period of operation. A hard deposit adheres to the gates when they are closed and fills the seats when they are open. These deposits restrict the movement of the gate, and when force is applied to open or close the valves, some of the threaded shafts have been stripped.

Rubber Pinch Valve: Figure 16 shows a rubber pinch valve that had been worn badly. It was used (length of service not available) to throttle the flow of process slurry through a 4-inch pipeline to the bull nozzle in the venturi unit.

Automatic Spray Valves for Inlet Gas Duct: To protect the neoprene lining from the hot inlet flue gas in the event that flow is lost in the slurry cooling sprays downstream, the sprays originally identified as "humidification sprays" in the stainless steel section of the inlet gas duct now serve as "emergency sprays." These sprays are activated from the control room if there is a rise in temperature in the area of the neoprene-lined equipment. During the current inspection, the emergency sprays in the inlet duct for the venturi/spray tower system were leaking appreciably. The leak was stopped during the inspection by closing a manually operated valve upstream. The leaking was continuous during operation of the scrubber. Leaking sprays are believed to account for the higher than expected corrosion rates of Cor-Ten A and mild steel at test locations 1002 and 2002 (refer to "Specimens Tested in Inlet Gas Duct" paragraph). Chlorides and sulfur (SO_3) in the flue gas dissolve in the water (or slurry) that leaks into the duct and produced a corrosive fluid.

Effect of Forced Oxidation and Flyash Content

During the fifth series of tests, spools of specimens were installed at various test locations in the scrubber systems to show the effect of forced oxidation of process slurry and flyash content of the flue gas on corrosion. The following tabulation gives information pertinent to the test made during the indicated periods in each scrubber system:

		Flyash content of inlet flue gas, gr/stdft^3		
Period	Total operating time, hr.	0.15 avg[a] % of total hr.	2 to 7 % of total hr.	Forced oxidation, % of total hr.
Venturi/spray tower				
10/20/76-2/27/78	8166 (340 days)	32	68	87
1/4/77-2/27/78	7211 (300 days)	36	64	98
TCA				
11/24/76-1/24/78	7632 (318 days)	20	80	38
11/24/76-2/4/77	1500 (62.5 days)	100	0	0
2/4/77-1/24/78	6132 (255.5 days)	0	100	47

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[a] Called "flyash free" flue gas at Shawnee test facility.

Because of variations in the test conditions, a precise evaluation was not possible; however, it appears that forced oxidation did not appreciably alter the corrosion in the systems (Tables I and III). It is not evident from results of these tests that variations in the flyash content of the flue gas affect corrosion rates. The pH level of the process slurry probably complicates the role of flyash with respect to corrosion of alloys.

Compilation of Corrosion Data

Table VI is a compilation of data for alloys and plastics tested in the two scrubber systems. This table summarizes information from Tables I and III on general corrosion (based on weight loss), pitting, and crevice corrosion for the alloys, and it gives a comparative evaluation for the plastics tested. The alloys and the plastics are listed in alphabetical order without identifying test conditions as given in Tables I and III.

On the basis of weight loss only, Cor-Ten A and mild steel A-283 had a wide range in corrosion rates, 1 to more than 185 mils per year. The maximum rate for Zirconium 702 was 2 mils per year. None of the other 12 alloys tested had a rate greater than 1 mil per year. However, each alloy tested showed evidence of localized attack except Hastelloy C-276 of which 19 specimens were exposed. Of the 286 specimens tested of 15 different alloys, 62 specimens (22% of total) were affected by pitting and/or crevice corrosion. Type 304L stainless steel was the alloy most susceptible to localized attack; 66% of the specimens were affected.

Of the five resin-type FRPs tested, all the Bondstrand 4000 (epoxy) and Derakane 510 (vinyl ester) were in good condition after the test. The condition of the other plastics was as follows: Atlac 711 (polyester), 12 good and 3 fair; Dion 6694 (bisphenol polyester) 16 good, 4 fair, and 3 poor; QuaCorr (furan), 2 good and 13 fair.

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The following firms supplied materials for preparing corrosion test specimens:

Alloys (sheet and filler metal)

Allegheny Ludlum Steel Corporation
Armco Steel Corporation
Cabot Corporation, Stellite Division
Carpenter Technology Corporation
Chicago Bridge and Iron Company
Eastern Stainless Steel Company
G. O. Carlson, Incorporated
Huntington Alloys
Jessop Steel Corporation
Metal Goods, Incorporated
Teledyne Wah Chang Albany
United States Steel Corporation

Plastics (fiberglass-reinforced)

Ameron, Corrosion Control Division
Dow Chemical Company
ICI United States, Incorporated
Koppers Company, Inc.
Quaker Oats Company

TABLE I

Corrosion Tests[a] Conducted in the Venturi/Spray Tower System of the Alkaline Wet-Scrubbing Process for Sulfur Dioxide Removal from Stack Gas at Shawnee Steam Plant

	Test specimens exposed in					
Exposure conditions	Inlet gas	Gas and liquor	Gas and liquor	Gas and liquor	Gas and droplets	Gas and droplets
Test location, No. (see Fig. 1)	1002[c]	1006[c]	1006[d]	1005[c]	1004[c]	1004[d]
Exposure period	10/20/76-2/27/78	10/20/76-2/27/78	1/4/77-2/27/78	1/4/77-2/27/78	10/20/76-2/27/78	1/4/77-2/27/78
Operating time, hr. (days)	8166 (340)	8166 (340)	7211 (300)	8166 (340)	8166 (340)	7211 (300)
Idle time, hr. (days)	3714 (155)	3714 (155)	2845 (119)	3714 (155)	3714 (155)	2845 (119)
Gas						
Temperature, °F	275-330	125-130	125-130	125-130	125-130	125-130
Velocity, ft/s	28-54	4.8-9.4	4.8-9.4	4.8-9.4	4.8-9.4	4.8-9.4
Flow rate, acfm x 10^3 at 330°F	18-35	18-35	18-35	18-35	18-35	18-35
Airflow in forced oxidation, scfm	-	-	-	-	-	-
Composition, % by volume						
SO_2	0.2-0.4	-	-	-	-	-
CO_2 (estimated)	10-18	-	-	-	-	-
O_2	3.5-11.5	-	-	-	-	-
H_2O (estimated)	8-15	-	-	-	-	-
HCl (estimated)	0.01	-	-	-	-	-
N_2 (estimated)	74	-	-	-	-	-
Flyash, gr/stdft^3	0.01-7	-	-	-	-	-
Liquor						
Temperature, °F	-	-	-	-	-	-
Solids, undissolved, % by wt.	-	-	-	-	-	-
Solids, dissolved, % by wt.	-	-	-	-	-	-
pH	-	-	-	-	-	-
Ionic composition, ppm						
$SO_3^=$	-	-	-	-	-	-
$SO_4^=$	-	-	-	-	-	-
Ca^{++}	-	-	-	-	-	-
Mg^{++}	-	-	-	-	-	-
Na^+	-	-	-	-	-	-
K^+	-	-	-	-	-	-
Cl^-	-	-	-	-	-	-
Corrosion rate of metals, mils/yr[e]						
AL 6X, weld AL 6X	< 1	< 1	Neg.	Neg.	Neg.	Neg.
Carpenter 20Cb-3, weld Carpenter 20Cb-3	1	< 1, Cm	< 1, Cm, Pm	< 1	C5, Pm	C6, Pm
Cor-Ten A, weld E8018-C3	> 33	> 100	21, P17	> 105	22	29
Hastelloy C-276, weld Hastelloy C-276	< 1	< 1	Neg.	< 1	Neg.	Neg.
Hastelloy G, weld Hastelloy G	-	< 1	Neg.	< 1	Neg.	Neg.
Inconel 625, weld Inconel 625	< 1	Neg.	Neg.	-	Neg.	Neg.
Jessop 700, weld Comete S2	-	< 1, Cm	Neg.	-	< 1, Cm	Neg.
Mild steel A-283, weld E6012	> 45	> 98	18, P25	> 185	26	26
Multimet, weld Multimet	-	< 1	Neg.	< 1	Neg.	Neg.
Nitronic 50, weld Nitronic 50	< 1	Cm, P7	Neg.	< 1	C8, P5	C2, Pm
Type 216, weld Type 216	< 1	-	-	< 1	-	-
Type 304L, weld Type 308L	1, Cm, Pm	C6, P11	C3, P22	C12, P31	C30, P13	C12, P12
Type 316L (2.6% Mo), weld Type 316L	< 1	< 1, C3	Neg.	< 1	P8, -[f]	< 1, C2
Type 317L (3.2% Mo), weld Type 309Cb	-	< 1, C2	< 1	-	C1, -[f]	< 1, P7
Zirconium 702, weld Zirconium 702	-	Neg.	< 1	< 1	< 1, P2	Neg.
Evaluation of plastics[g]						
Atlac 711, polyester	-	Fair	Fair	Good	Good	Fair
Bondstrand 4000, epoxy	-	Good	Good	Good	Good	Good
Derakane 510, vinyl ester	-	Good	Good	Good	Good	Good
Dion 6694, bisphenol polyester	Poor	Fair	Good	Good	Good	Good
QuaCorr, furan resin	-	Fair[h]	Fair[h]	Fair[h]	Fair[h]	Fair[h]

TABLE I

(CONTINUED)

Exposure conditions	Test specimens exposed in Exhaust gas (heated)	Exhaust gas (heated)	Effluent liquor	Effluent liquor	Aerated liquor[b]	Liquor in clarifier
Test location, No. (see Fig. 1)	1014[c]	1015[c]	1008[c]	1008[d]	1017[d]	1018[c]
Exposure period	10/20/76-2/27/78	10/20/76-2/27/78	10/20/76-2/27/78	1/4/77-2/27/78	1/4/77-2/27/78	10/20/76-2/27/78
Operating time, hr. (days)	8166 (340)	8166 (340)	8166 (340)	7211 (300)	7211 (300)	8166 (340)
Idle time, hr. (days)	3714 (155)	3714 (155)	3714 (155)	2845 (119)	2845 (119)	3714 (155)
Gas						
Temperature, °F	235-265	235-265	-	-	-	-
Velocity, ft/s	31-62	31-62	-	-	-	-
Flow rate, acfm x 10^3 at 330°F	20-40	20-40	-	-	-	-
Airflow in forced oxidation, scfm	-	-	-	-	50-400	-
Composition, % by volume						
SO_2	0.02-0.10	0.02-0.10	-	-	-	-
CO_2 (estimated)	11-19	11-19	-	-	-	-
O_2	4.5-12.5	4.5-12.5	-	-	-	-
H_2O (estimated)	6-16	6-16	-	-	-	-
HCl (estimated)	-	-	-	-	-	-
N_2 (estimated)	69	69	-	-	-	-
Flyash, gr/stdft^3	0.01-0.04	0.01-0.04	-	-	-	-
Liquor						
Temperature, °F	-	-	85-150	85-150	100-125	85-100
Solids, undissolved, % by wt.	-	-	11-18	11-18	12-18	5-40
Solids, dissolved, % by wt.	-	-	10-20	10-20	17-50	5-10
pH	-	-	5.4-5.8	5.4-5.8	5-5.5	4-6
Ionic composition, ppm						
$SO_3^=$	-	-	50-400	50-400	150-1000	50-1000
$SO_4^=$	-	-	650-2600	650-2600	2000-9200	650-9200
Ca^{++}	-	-	400-2900	400-2900	1900-9800	400-9800
Mg^{++}	-	-	200-1600	200-1600	500-2400	200-2400
Na^+	-	-	20-160	20-160	10-330	10-330
K^+	-	-	20-150	20-150	40-500	20-500
Cl^-	-	-	600-6000	600-6000	1100-11,000	600-11,000
Corrosion rate of metals, mils/yr[e]						
AL 6X, weld AL 6X	1	1	Neg.	Neg.	Neg.	-
Carpenter 20Cb-3, weld Carpenter 20Cb-3	< 1	1	Neg.	Neg.	Neg.	Neg.
Cor-Ten A, weld E8018-C3	1	3	1, C5	-	11, P9	1, C8
Hastelloy C-276, weld Hastelloy C-276	1	1	Neg.	Neg.	Neg.	Neg.
Hastelloy G, weld Hastelloy G	-	-	Neg.	Neg.	Neg.	-
Inconel 625, weld Inconel 625	< 1	< 1	-	-	-	-
Jessop 700, weld Comete S2	1	1	Neg.	Neg.	Neg.	-
Mild steel A-283, weld E6012	1	3	2, C4	1	16, P6	1, C3
Multimet, weld Multimet	-	-	-	Neg.	Neg.	-
Nitronic 50, weld Nitronic 50	1	1	Neg.	Neg.	C1, P3	Neg.
Type 216, weld Type 216	1	-	Neg.	Neg.	Neg.	-
Type 304L, weld Type 308L	1	1	Neg.	-	-	Neg.
Type 316L (2.6% Mo), weld Type 316L	1	1	Neg.	Neg.	Neg.	Neg.
Type 317 (3.2% Mo), weld Type 309Cb	1	1	Neg.	Neg.	Neg.	-
Zirconium 702, weld Zirconium 702	1	2	Neg.	Neg.	-	-
Evaluation of plastics[g]						
Atlac 711, polyester	-	-	Good	Good	Good	Good
Bondstrand 4000, epoxy	-	-	Good	Good	Good	Good
Derakane 510, vinyl ester	-	-	Good	Good	Good	Good
Dion 6694, bisphenol polyester	Poor	Poor	Good	Good	Good	Good
QuaCorr, furan resin	-	-	Good	Good	Fair[h]	Fair[h]

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[a] The tests conducted at location 1011 were affected greatly by erosion in addition to corrosion. Results of these tests are given in Table II.

[b] Liquor in tank D-108 was sparged with air during the forced oxidation tests.

[c] Forced oxidation was used 87% of the 8166-hour (accumulative) operating period; flyash content of inlet flue gas averaged 0.15 gr/stdft³ 32% of period and 2 to 7 gr./stdft³ 68% of period.

[d] Forced oxidation was used 98% of the 7211-hour (accumulative) operating period; flyash content of inlet flue gas averaged 0.15 gr/stdft³ 36% of period and 2 to 7 gr/stdft³ 64% of period.

[e] Negligible (Neg.) indicates corrosion rates of less than 0.05 mil per year; < 1 indicates corrosion rates of 0.05 to 0.49 mil per year; "C" or "P" preceding a number indicates crevice corrosion or pits, respectively, during the exposure period to the depth in mils shown by the number; and "Cm" or "Pm" indicates minute crevice or minute pit. The sign ">" indicates that the specimen failed and the penetration rate in mils per year was greater than the number given.

[f] Attack of weld.

[g] Evaluation: Good, little or no change in condition of specimen; fair, definite change, probably could be used; poor, failed or severely damaged.

[h] Specimen crazed.

TABLE II

Erosion-Corrosion[a] of Specimens Tested Below the Venturi at Test Location 1011

	Test specimens exposed in gas and spray		
Exposure conditions			
Test location, No. (see Fig. 1)	1011	1011A[b]	1011B
Exposure period	10/20/76-10/26/77	6/16/77-6/20/77	11/9/77-2/27/78
Operating time, hr. (days)	5547 (231)	70 (2.9)	2226 (92.8)
Idle time, hr. (days)	3357 (140)	18 (0.7)	414 (17.2)
Gas and spray			
Temperature, °F	100-170	-	100-170
Velocity, ft/s	60-110	110	55-110
Flow rate, acfm x 10^3 at 330°F	20-35	35	18-35
Corrosion rate of metals,[c] mils/yr			
Carpenter 20Cb-3, weld Carpenter 20Cb-3	5, C2	120	4, C2
Cor-Ten A, weld E8018	> 2450	2400, C17	> 1200
Hastelloy C-276, weld Hastelloy C-276	5, C2	< 1, P4	6, C2
Hastelloy G, weld Hastelloy G	4, C2	2, P3	4, C1
Haynes 6B, weld Haynes No. 25	1	228	1
Inconel 625, weld Inconel 625	4, C2	Negligible	4, C1
Jessop 700, weld Comete S2	7, C1	121, -[d]	3, C2
Mild steel A-283, weld E6012	> 3290	2590, C20	> 1000
Multimet, weld Multimet	5, C1	43	3, C1
Nitronic 50, weld Nitronic 50	6, C5	400, C4	3, C10
Type 304L, weld Type 308L	> 60	1160	> 150
Type 316L (2.6% Mo), weld Type 316L	9, C1	460, -[d]	4, C9
Type 317L (3.2% Mo), weld Type 309Cb	13, C3	258, -[d]	4, C10
Zirconium 702, weld Zirconium 702	> 75	320, C5	6
Evaluation of plastic[e]			
Dion 6694, bisphenol polyester	Poor	Fair	Poor

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[a] The results of tests conducted at other locations in the venturi/spray-tower system at which the attack of alloys was mainly corrosion (negligible erosion) are given in Table I.

[b] Water only (15-20 gpm) was used to cool the inlet gas upstream from test location 1011. When the cooling water reached the corrosion test specimens, its pH was probably below 2.0 based on earlier tests conducted at Colbert Steam Plant.

[c] "C" or "P" preceding a number indicates crevice corrosion or pits, respectively, during the exposure period to the depth in mils shown by the number; "Cm" or "Pm" indicates minute crevice or pit. The sign ">" indicates that the specimen failed and the penetration rate in mils per year was greater than the number given.

[d] Attack of weld.

[e] Evaluation: Fair, definite change in condition of specimen but not severe; poor, deterioration was severe.

TABLE III

Corrosion Tests Conducted in the TCA System of the Alkaline-Wet-Scrubbing Process for Sulfur Dioxide Removal from Stack Gas at Shawnee Steam Plant

	Test specimens exposed in					
	Inlet gas	Gas and liquor	Gas and droplets	Gas and droplets	Gas and mist	Gas and mist
Exposure conditions						
Test location, No. (see Fig. 2)	2002[a]	2006[a]	2005[b]	2005[c]	2004[b]	2004[c]
Exposure period	11/24/76-1/24/78	11/24/76-1/24/78	11/24/76-2/4/77	2/4/77-1/24/78	11/24/76-2/4/77	2/4/77-1/24/78
Operating time, hr. (days)	7632 (318)	7632 (318)	1500 (62.5)	6132 (255.5)	1500 (62.5)	6132 (255.5)
Idle time, hr. (days)	2592 (108)	2592 (108)	228 (9.5)	2364 (98.5)	228 (9.5)	2364 (98.5)
Gas						
Temperature, °F	260-310	70-150	70-125	70-125	70-125	70-125
Velocity, ft/s	27-40	7.5-12.5	12.5	7.5-12.5	7.9	4.7-7.9
Flow rate, acfm x 10^3 at 300°F	18-30	12-20	20	12-20	12-20	12-20
Airflow during forced oxidation, scfm	-	-	-	-	-	-
Composition, % by volume						
SO_2	0.2-0.4	-	-	-	-	-
CO_2 (estimated)	10-18	-	-	-	-	-
O_2	4.5-12.0	-	-	-	-	-
H_2O (estimated)	8-15	-	-	-	-	-
HCl (estimated)	0.01	-	-	-	-	-
N_2 (estimated)	74	-	-	-	-	-
Flyash, gr/stdft^3	0.01-7	-	-	-	-	-
Liquor						
Temperature, °F	-	-	-	-	-	-
Solids, undissolved, % by wt.	-	-	-	-	-	-
Solids, dissolved, % by wt.	-	-	-	-	-	-
pH	-	-	-	-	-	-
Ionic composition, ppm						
$SO_3^=$	-	-	-	-	-	-
$SO_4^=$	-	-	-	-	-	-
Ca^{++}	-	-	-	-	-	-
Mg^{++}	-	-	-	-	-	-
Na^+	-	-	-	-	-	-
K^+	-	-	-	-	-	-
Cl^-	-	-	-	-	-	-
Corrosion rate of metals, mils/yr[e]						
AL 6X, weld AL 6X	-	< 1	Neg.	Neg.	Neg.	Neg.
Carpenter 20Cb-3, weld Carpenter 20Cb-3	< 1, Pm	Neg.	Neg.	Neg.	< 1	Neg.
Cor-Ten A, weld E8018-C3	14, C25	14	96, C25	40, C18	54, C26	> 175
Hastelloy C-276, weld Hastelloy C-276	< 1	Neg.	-	Neg.	Neg.	Neg.
Hastelloy G, weld Hastelloy G	-	Neg.	Neg.	Neg.	Neg.	Neg.
Inconel 625, weld Inconel 625	< 1, Pm	-	Neg.	Neg.	-	-
Jessop 700, weld Comete S2	-	Neg.	Neg.	Neg.	< 1	Neg.
Mild steel A-283, weld E6012	15, C27	13	81, C16	47	56, C25	18, C45
Multimet, weld multimet	-	< 1	Neg.	Neg.	Neg.	Neg.
Nitronic 50, weld Nitronic 50	< 1	Cm, P7	Neg.	Neg.	< 1	Neg.
Type 216, weld Type 216	-	-	-	Neg.	Neg.	Neg.
Type 304L, weld Type 308L	1	C16, P27	C12, P21	C16, P20	C10, P35	C20, P23
Type 316L (2.6% Mo), weld Type 316L	< 1	< 1, P3	< 1	Neg.	< 1, C6	Neg.
Type 317L (3.2% Mo), weld Type 309Cb	-	< 1	< 1	Neg.	< 1, C2	Neg.
Zirconium 702, weld Zirconium 702	-	Neg.	-	Neg.	Neg.	Neg.
Evaluation of plastics[h]						
Atlac 711, polyester	-	Good	Good	Good	Good	Good
Bondstrand 4000, epoxy	-	Good	Good	Good	Good	Good
Derakane 510, vinyl ester	-	Good	Good	Good	Good	Good
Dion 6694, bisphenol polyester	Fair	Good	Good	Good	Good	Good
QuaCorr, furan resin[i]	-	Fair	Fair	Fair	Fair	Fair

TABLE III

(CONTINUED)

	Test specimens exposed in				
Exposure conditions	Exhaust gas (heated)	Exhaust gas (heated)	Effluent liquor	Effluent liquor	Liquor in clarifier
Test location, No. (see Fig. 2)	2014[a,d]	2015[a]	2008[b]	2008[c]	2013[a]
Exposure period	11/24/76-1/24/78	11/24/76-1/24/78	11/24/76-2/4/77	2/4/77-1/24/78	11/24/76-1/24/78
Operating times, hr. (days)	7632 (318)	7632 (318)	1500 (62.5)	6132 (255.5)	7632 (318)
Idle time, hr. (days)	2592 (108)	2592 (108)	228 (9.5)	2364 (98.5)	2592 (108)
Gas					
Temperature, °F	255-265	255-265	-	-	-
Velocity, ft/s	27-40	27-40	-	-	-
Flow rate, acfm x 10^3 at 300°F	18-30	18-30	-	-	-
Airflow during forced oxidation, acfm	-	-	-	150-600	-
Composition, % by volume					
SO_2	0.02-0.10	0.02-0.10	-	-	-
CO_2 (estimated)	11-19	11-19	-	-	-
O_2	5.0-12.5	5.0-12.5	-	-	-
H_2O (estimated)	8-15	8-15	-	-	-
HCl (estimated)	-	-	-	-	-
N_2 (estimated)	69	69	-	-	-
Flyash, gr/stdft^3	0.01-0.04	0.01-0.04	-	-	-
Liquor					
Temperature, °F	-	-	85-130	85-130	85-100
Solids, undissolved, % by wt.	-	-	7-16	7-16	0-40
Solids, dissolved, % by wt.	-	-	3.5-9.5	3-10	5-10
pH	-	-	5.0-5.3	3.8-5.4	4.6
Ionic composition, ppm					
$SO_3^=$	-	-	100-400	100-7600	100-7600
$SO_4^=$	-	-	500-2500	500-2800	500-2800
Ca^{++}	-	-	1000-1800	300-1900	300-1900
Mg^{++}	-	-	300-700	300-10,000	300-10,000
Na^+	-	-	20-30	20-105	20-105
K^+	-	-	20-75	20-105	20-105
Cl^-	-	-	2900-3400	1000-3500	1000-3500
Corrosion rate of metals, mils/yr[e]					
AL 6X, weld AL 6X	P8, -[f]	< 1	Neg.	Neg.	Neg.
Carpenter 20Cb-3, weld Carpenter 20Cb-3	< 1	Neg.	Neg.	Neg.	Neg.
Cor-Ten A, weld E8018-C3	6	2	1	8	1, -[f]
Hastelloy C-276, weld Hastelloy C-276	Neg.	< 1	-	Neg.	Neg.
Hastelloy G, weld Hastelloy G	< 1, P8	Neg.	Neg.	Neg.	-
Inconel 625, weld Inconel 625	< 1, P7	Neg.	Neg.	Neg.	-
Jessop 700, weld Comete S2	1, P7, -[f]	< 1	-	Neg.	-
Mild steel, A-283, weld E6012	7	2	1	2, Cm	4, Cm
Multimet, weld Multimet	< 1, P7	Neg.	Neg.	Neg.	-
Nitronic 50, weld Nitronic 50	1,[g] P7	< 1	Neg.	< 1, Pm	Neg.
Type 216, weld Type 216	1,[g] P8	-	-	Neg.	-
Type 304L, weld Type 308L	1,[g] P6	< 1	Neg.	C7, Pm	Neg.
Type 316L (2.6% Mo), weld Type 316L	1,[f,g] P5	< 1	Neg.	Neg.	Neg.
Type 317L (3.2% Mo), weld Type 309Cb	1,[f] P11	< 1	Neg.	-	Neg.
Zirconium 702, weld Zirconium 702	Neg.	< 1	-	Neg.	-
Evaluation of plastics[h]					
Atlac 711, polyester	-	-	-	Good	-
Bondstrand 4000, epoxy	-	-	-	Good	-
Derakane 510, vinyl ester	-	-	-	Good	-
Dion 6694, bisphenol polyester	Fair	Fair	Good	Good	Good
QuaCorr, furan resin[i]	-	-	-	Fair	-

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[a] Forced oxidation was used 58% of the 7632-hour (accumulative) operating period; flyash content of inlet flue gas averaged 0.15 gr/stdft^3 20% of period and 2 to 7 gr/stdft^3 80% of period.

[b] No forced oxidation used; flyash content of inlet flue gas averaged 0.15 gr/stdft^3 100% of the 1500-hour (accumulative) operating period.

[c] Forced oxidation was used 47% of the 6132-hour (accumulative) operating period; flyash content of inlet flue gas was 2 to 7 gr/stdft^3 100% of the period.

[d] The test specimens were mounted on a horizontal probe with the faces of the disks in a vertical position; alloys that were corroded showed the greatest attack on the bottom half of the disk.

[e] Negligible (Neg.) indicates corrosion rates of less than 0.05 mil per year; < 1 indicates rates of 0.05 to 0.49 mil per year; "C" or "P" preceding a number indicates crevice corrosion or pits, respectively, during the exposure period to the depth in mils shown by the number; and "Cm" or "Pm" indicates minute crevice or minute pit. The sign ">" indicates that the specimen failed and the penetration rate in mils per year was greater than the number given.

[f] Attack of weld.

[g] Specimen cracked.

[h] Evaluation: Good, little or no change in condition of specimen; fair, definite change, probably could be used.

[i] Specimens crazed.

TABLE IV

Composition of Alloys Tested in the Alkaline Wet-Scrubbing Systems for Sulfur Dioxide Removal from Stack Gas at Shawnee Steam Plant

Alloys	Chemical composition, % by weight											
	C	Cr	Ni	Fe	Cu	Mo	Mn	Si	P	S	Al	Ti	Others
AL 6X[a]	0.027	20.32	24.17	Bal.	-	6.42	1.46	0.56	0.025	0.004	-	-	N, 0.03
Carpenter[a] 20Cb-3	0.06[b]	19-21	32.5-35.0	Bal.	3-4	2-3	2.00[b]	1.00[b]	0.035[b]	0.035[b]	-	-	Cb + Ta, 8 x C (1% max.)
Cor-Ten A[a]	0.09	0.72	0.03	Bal.	0.29	-	0.40	0.39	0.09	0.022	-	-	-
Hastelloy C-276[a]	0.002	15.87	Bal.	5.96	-	16.32	0.49	< 0.01	0.012	0.010	-	-	Co, 1.84; W, 3.51; V, 0.25
Hastelloy G[a]	0.02	21.72	Bal.	18.68	1.77	6.69	1.30	0.34	0.021	0.011	-	-	Co, 1.57; Cb + Ta, 2.3; W, 0.54
Haynes 6B	0.9-1.4	28-32	3.0[b]	3.0[b]	-	1.5[b]	2.0[b]	2.0[b]	-	-	-	-	Co, Bal.; W, 3.5-5.5
Inconel 625	0.1[b]	20-23	Bal.	5.00[b]	-	8-10	0.5[b]	0.5[b]	0.015[b]	0.015[b]	0.4[b]	0.4[b]	Co, 1.0[b]; Cb + Ta, 3.15-4.15
Jessop 700[c]	0.03	21.00	25.00	Bal.	-	4.5	1.70	0.50	-	-	-	-	Cb, 0.30
Mild steel A-283[a]	0.13	-	-	Bal.	-	-	0.45	-	0.012	0.016	-	-	-
Multimet	0.08-0.16	20-22.5	19-21	Bal.	-	2.5-3.5	1.0-2.0	1.0[b]	-	-	-	-	Cb + Ta, 0.75-1.25; Co, 18.5-21; N, 0.1-0.2; W, 2-3
Nitronic 50	0.06[b]	20.5-23.5	11.5-13.5	Bal.	-	1.5-3.0	4.0-6.0	1.0[b]	0.04[b]	0.03[b]	-	-	N, 0.2-0.4; Cb, 0.1-0.3; V, 0.1-0.3
Type 216[a]	0.069	19.54	6.77	Bal.	-	2.31	8.21	0.25	0.025	0.005	-	-	N, 0.358
Type 304L	0.03	18-20	8-12	Bal.	-	-	2.00[b]	1.00[b]	0.045[b]	0.030[b]	-	-	-
Type 316L[a]	0.03	17.05	13.05	Bal.	0.18	2.55	1.55	0.64	0.041	0.003	-	-	-
Type 317L[a]	0.022	18.61	13.62	Bal.	0.45	3.16	1.62	0.60	0.021	0.009	0.012	0.004	B, 0.0008; Cb, 0.02; Co, 0.17; N, 0.065
Zirconium 702[a]	0.015	-[d]	-	-[d]	-	-	-	-	-	-	-	-	N, 0.05; Hf, < 0.10; Zr + Hf, > 99.2

[a] Analysis was supplied with the material.
[b] Maximum.
[c] Nominal analysis.
[d] Cr + Fe, 0.10% by weight.

TABLE V

Durometer Hardness of Neoprene Protective Linings and Coverings in Alkaline Wet-Scrubbing Systems for Removing Sulfur Dioxide from Shawnee Steam Plant Stack Gases

(Exposure period 8/17/72-4/12/78[a])

Location of area of lining or covering tested	Durometer A hardness[b]			
	Previous		Current	
	Value	°F	Value	°F
Venturi/Spray Tower System				
Accumulative operating time: 31,370 hr. or 1307 days (9/5/72-4/10/78)				
Crossover duct from flooded elbow to spray tower				
North wall 18 in. above bottom, 1 ft from tower	54-60[c]	73	43	62
South wall 18 in. above bottom, 1 ft from tower	-	-	43-45	62
Spray tower walls				
6 in. above cone-shaped bottom (elev. 371 ft)	53-62[d]	61	46-50	62
6 ft above trapout tray (elev. 387 ft)	53-60[e]	-	48-53	53
11 ft above trapout tray (elev. 392 ft)	52-56[d]	57	48-52	75
3 in. below mist eliminator (elev. 400 ft)	54-60[e]	-	41-46	75
3 in. above mist eliminator (elev. 401 ft)	42-47[c]	73	40 45	57
1 ft below stainless steel duct (elev. 406 ft)	46-50[d]	55	42-45	57
Tanks				
D-104				
Above liquid level	-	-	67-70	56
Below liquid level	65-72[d]	73	67-73	56
Agitator blades	66-71[d]	73	67-71	56
D-109 (orig. D-303)				
Above liquid level	64-72[d]	55	61-67	57
D-401 (reslurry tank)				
Above liquid level	60-66[c]	82	61-67	72
Pumps				
G-102 (clarifier underflow)				
Suction side of casing	-	-	65-69	77
Seal side of casing	-	-	66-69	77
Impeller	-	-	63-67	77
G-105				
Suction side of casing	-	-	60	55
Seal side of casing	-	-	65	55
Impeller	-	-	62-65	55
G-109				
Suction side of casing	-	-	48-52	55
Seal side of casing	-	-	61-63	55
Impeller	-	-	61-63	55
Turbulent Contact Absorber				
Accumulative operating time: 33,845 hr. or 1410 days (8/17/72-4/12/78)				
Scrubber tower				
4 in. above inlet gas duct (elev. 376 ft)	55-62[d]	68	36-45	72
2 ft below bottom grid (elev. 378 ft)	45-48[f]	90	46-48	72
6 in. above bottom grid (elev. 380 ft)	58-60[e]	60	47-50	69
3 ft above second grid (elev. 386 ft)	57-61[d]	72	47-51	66
2 ft below mist eliminator (elev. 403 ft)	55-61[d]	72	44-50	56
1 ft above mist eliminator (elev. 406 ft)	45-53[d]	72	43-45	66
4 in. above top of tower in duct (elev. 408 ft)	53-65[d]	72	47-51	66
Tanks				
D-203				
Above liquid level	61-66[c]	82	69-70	72
Below liquid level	72-75[c]	82	61-63	72
D-204				
Below liquid level	60-66[e]	40	52-61	56
Bottom agitator blades	60-70[e]	40	45-47	56

---

[a] Exposure period relates mainly to neoprene linings in towers and tanks; it is assumed that the liners in pumps have been replaced since operation began 8/17/72.

[b] A Shore A2 D2240 Durometer was used to determine hardness values of the linings under prevailing atmospheric conditions. The ASTM Standard D2240-68 specifies that tests for hardness of rubber be made at 73°F (note variations in test temperature).

[c] See third interim report, S-470 (March 1976).

[d] See second interim report, S-465A (May 1974).

[e] See first interim report, S-465 (October 1973).

[f] See fourth interim report, S-472 (April 1977).

TABLE VI

Compilation of Corrosion Data[a] for Tests Conducted in the Venturi/Spray Tower and TCA Scrubber Systems

(Test period: 10/27/76-2/27/78)

		Corrosion							
						Specimens with			
		On basis of wt. loss, mils/yr	Specimens pitted[b]			Crevice corrosion			Pitting or crevice corrosion
Alloy	Number of tests		Number of	Depth in mils Min.	Max.	Number of	Depth in mils[b] Min.	Max.	
AL 6X	21	Neg. to 1	1	-	8	0	-	-	1
Carpenter 20Cb-3	23	Neg. to 1	4	-	m	4	m	6	5
Cor-Ten A	22	1 to > 175	1	-	9	6	5	26	7
Hastelloy C-276	19	Neg. to 1	0	-	-	0	-	-	0
Hastelloy G	19	Neg. to < 1	1	-	8	0	-	-	1
Inconel 625	15	Neg. to < 1	2	m	7	0	-	-	2
Jessop 700	16	Neg. to 1	1	-	7	2	-	m	3
Mild steel A-285	23	1 to > 185	1	-	6	8	m	45	9
Multimet	16	Neg. to < 1	1	-	7	0	-	-	1
Nitronic 50	23	Neg. to 1	7	m	7	5	m	8	7
Type 216	11	Neg. to 1	1	-	8	0	-	-	1
Type 304L	21	Neg. to 1	14	m	35	13	7	30	13
Type 316L (2.6% Mo)	23	Neg. to 1	3	3	8	3	2	6	6
Type 317L (3.2% Mo)	18	Neg. to 1	2	-	7	3	1	2	5
Zirconium 702	16	Neg. to 2	1	-	2	0	-	-	1

	Evaluation,[c] number of specimens		
Plastics	Good	Fair	Poor
Atlac 711, polyester	12	3	0
Bondstrand 4000, epoxy	15	0	0
Derakane 510, vinyl ester	15	0	0
Dion 6694, bisphenol polyester	16	4	3
QuaCorr, furan resin	2	13	0

---

[a] Data compiled from Tables I and III but do not include erosion-corrosion data in Table II.

[b] The numerical value shows the depth of penetration by pitting or crevice corrosion in mils during test period. Minute penetration, "m."

[c] Good, little or no change in condition of specimen; fair, definite change--probably could be used; poor, failed or severely damaged.

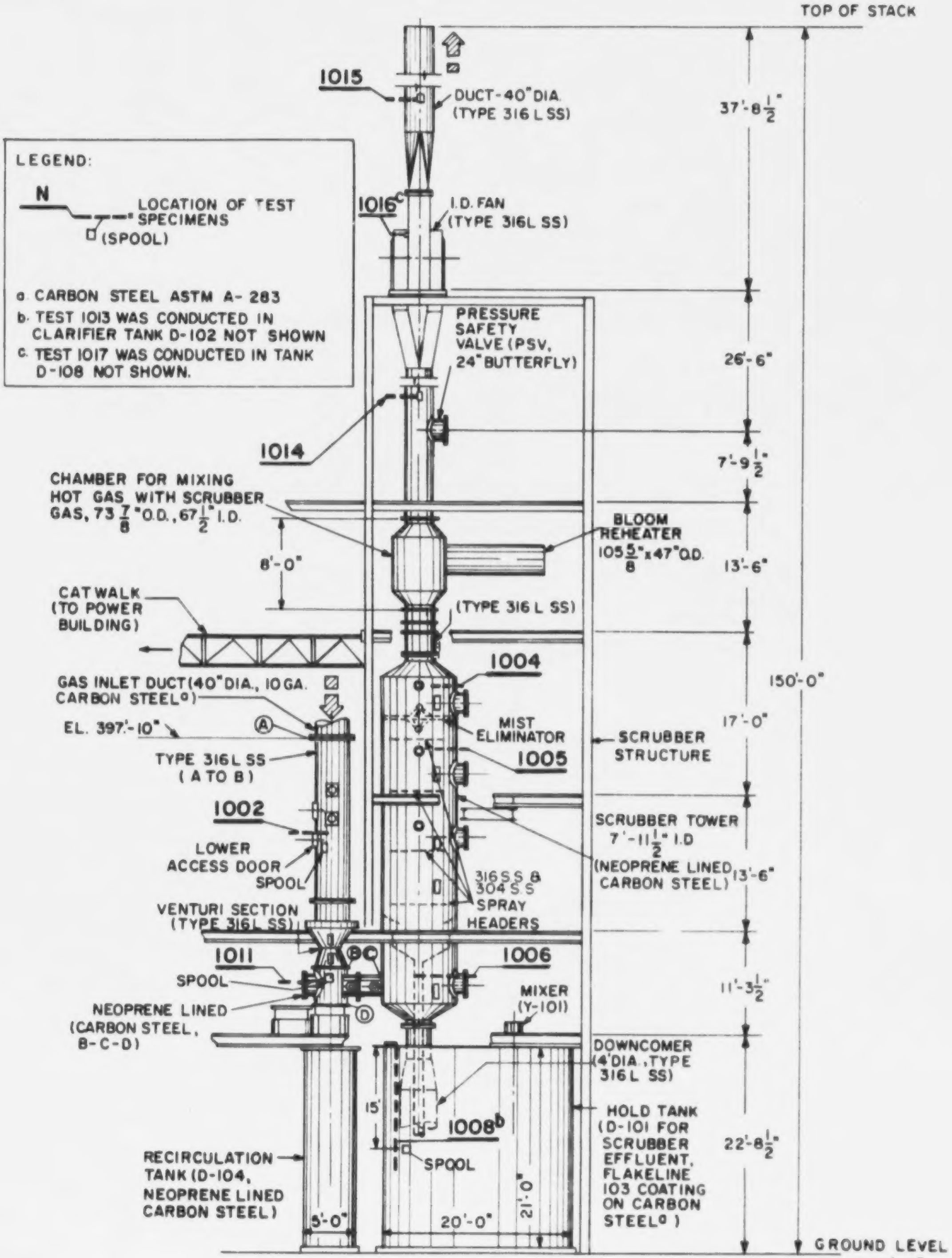

TOP OF STACK
1015
DUCT-40" DIA.
(TYPE 316 L SS)
37'-8 1/2"
LEGEND:
N
LOCATION OF TEST SPECIMENS
(SPOOL)
a. CARBON STEEL ASTM A-283
b. TEST 1013 WAS CONDUCTED IN CLARIFIER TANK D-102 NOT SHOWN
c. TEST 1017 WAS CONDUCTED IN TANK D-108 NOT SHOWN.
1016c
I.D. FAN
(TYPE 316L SS)
PRESSURE SAFETY VALVE (PSV, 24" BUTTERFLY)
26'-6"
1014
7'-9 1/2"
CHAMBER FOR MIXING HOT GAS WITH SCRUBBER GAS, 73 7/8" O.D., 67 1/2" I.D.
BLOOM REHEATER
105 5/8" x 47" O.D.
8'-0"
13'-6"
CATWALK (TO POWER BUILDING)
(TYPE 316 L SS)
1004
GAS INLET DUCT (40" DIA., 10 GA. CARBON STEELa)
EL. 397'-10"
A
MIST ELIMINATOR
SCRUBBER STRUCTURE
17'-0"
150'-0"
TYPE 316L SS (A TO B)
1005
1002
SCRUBBER TOWER
7'-11 1/2" I.D
LOWER ACCESS DOOR
SPOOL
(NEOPRENE LINED CARBON STEEL)
13'-6"
316 S.S & 304 S.S
SPRAY HEADERS
VENTURI SECTION (TYPE 316L SS)
B
C
1011
1006
SPOOL
11'-3 1/2"
NEOPRENE LINED (CARBON STEEL, B-C-D)
D
MIXER (Y-101)
DOWNCOMER (4' DIA., TYPE 316L SS)
15'
1008b
SPOOL
HOLD TANK (D-101 FOR SCRUBBER EFFLUENT, FLAKELINE 103 COATING ON CARBON STEELa)
22'-8 1/2"
RECIRCULATION TANK (D-104, NEOPRENE LINED CARBON STEEL)
21'-0"
5'-0"
20'-0"
GROUND LEVEL
EL. 345'-0"

FIGURE 1

Venturi/Spray Tower System (C-101)

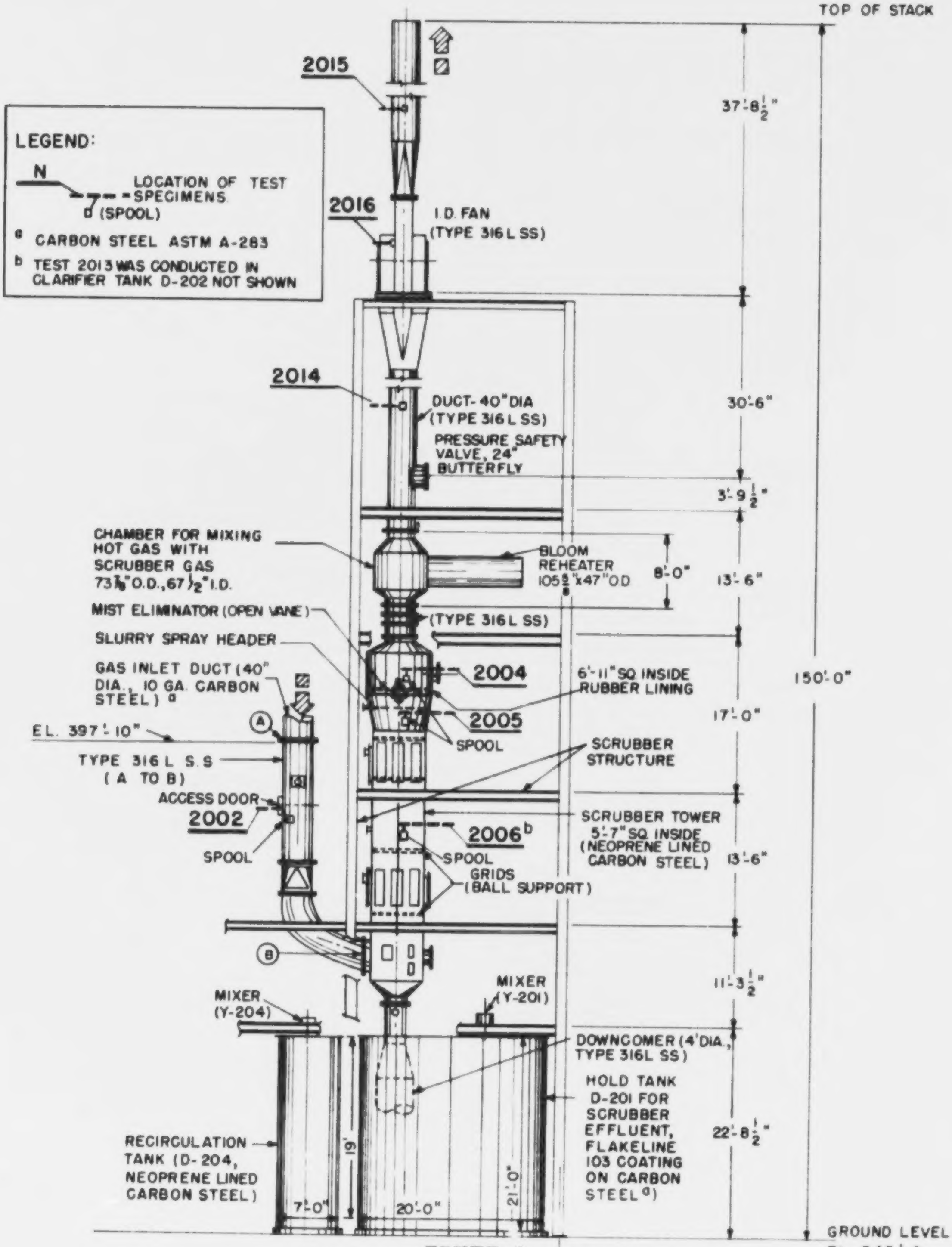
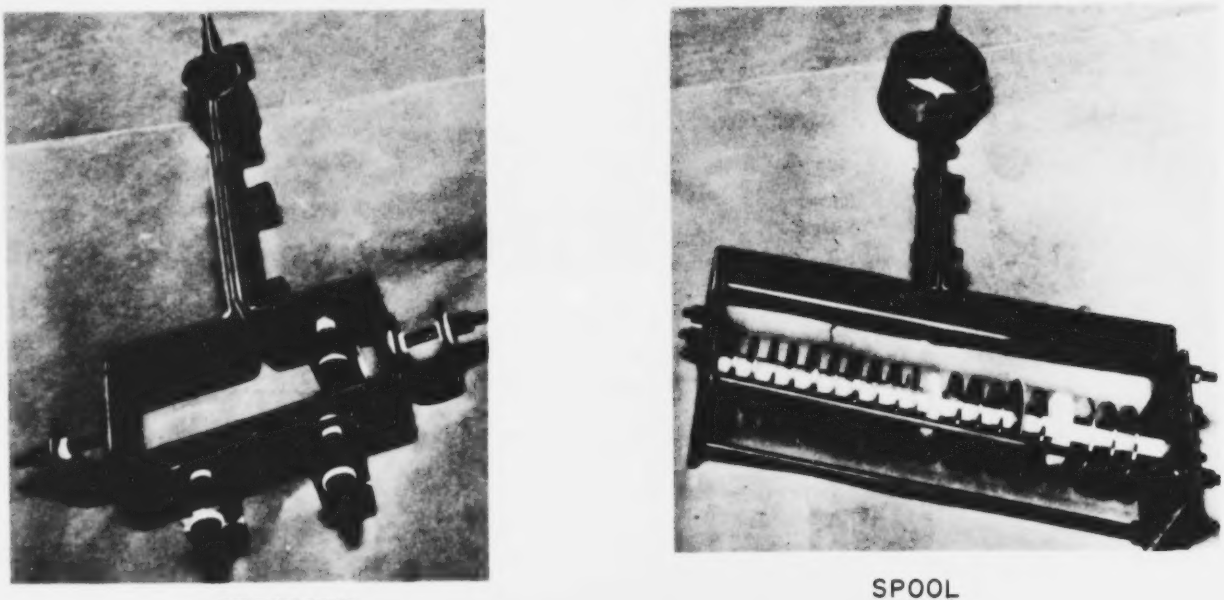

TOP OF STACK
2015
37'-8 1/2"
LEGEND:
N
LOCATION OF TEST SPECIMENS.
(SPOOL)
a CARBON STEEL ASTM A-283
b TEST 2013 WAS CONDUCTED IN CLARIFIER TANK D-202 NOT SHOWN
2016
I.D. FAN (TYPE 316 L SS)
2014
DUCT- 40" DIA (TYPE 316 L SS)
PRESSURE SAFETY VALVE, 24" BUTTERFLY
30'-6"
3'-9 1/2"
CHAMBER FOR MIXING HOT GAS WITH SCRUBBER GAS 73 7/8" O.D., 67 1/2" I.D.
BLOOM REHEATER 105 1/2" x 47" OD a
8'-0"
13'-6"
MIST ELIMINATOR (OPEN VANE)
(TYPE 316 L SS)
SLURRY SPRAY HEADER
GAS INLET DUCT (40" DIA., 10 GA. CARBON STEEL) a
2004
6'-11" SQ INSIDE RUBBER LINING
150'-0"
2005
17'-0"
EL. 397'-10"
A
SPOOL
TYPE 316 L S.S (A TO B)
SCRUBBER STRUCTURE
ACCESS DOOR
2002
SPOOL
2006b
SCRUBBER TOWER 5'-7" SQ. INSIDE (NEOPRENE LINED CARBON STEEL)
13'-6"
SPOOL
GRIDS (BALL SUPPORT)
B
11'-3 1/2"
MIXER (Y-204)
MIXER (Y-201)
DOWNCOMER (4' DIA., TYPE 316L SS)
HOLD TANK D-201 FOR SCRUBBER EFFLUENT, FLAKELINE 103 COATING ON CARBON STEEL a)
22'-8 1/2"
RECIRCULATION TANK (D-204, NEOPRENE LINED CARBON STEEL)
19'
21'-0"
7'-0"
20'-0"
GROUND LEVEL
EL 345'-0

FIGURE 2

Turbulent Contact Absorber System, TCA (C-201) (Mobile Bed)



STRESSED
(U-Bend)

SPOOL
(Disk)

PROBE (Disk)

FIGURE 3

Typical Assemblies of Corrosion Test Specimens

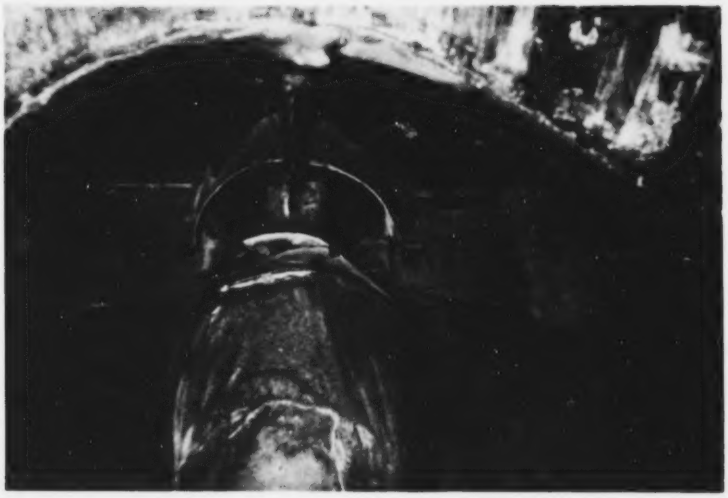


FIGURE 4

Erosion-Corrosion of Components Immediately Below Adjustable Plug in Venturi (Looking Upward)

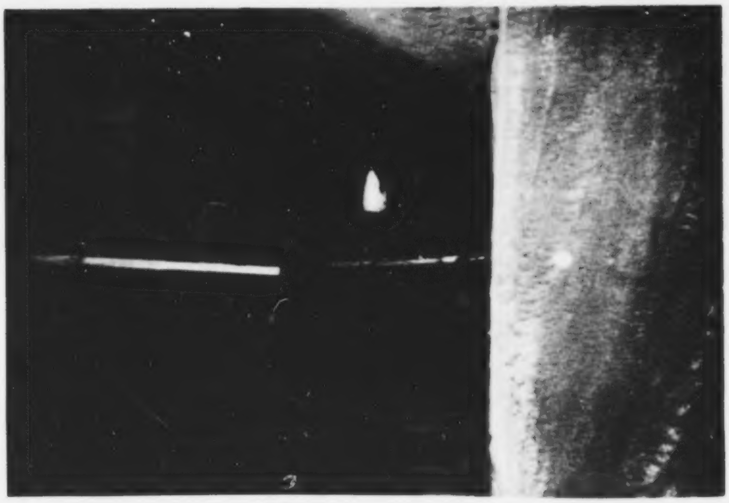


FIGURE 5

Flooded Elbow: Blisters in Neoprene Lining on North Wall (Left) and Heavy Scale Overhead (Inside Spray Tower Looking East)

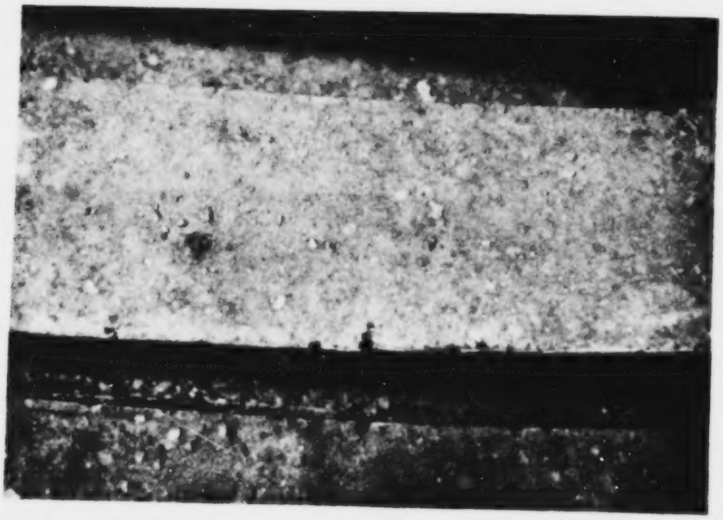


FIGURE 6

Pitting Corrosion of Type 316 Mist-Eliminator Vane in Spray Tower After Approximately 18,500 Operating Hours

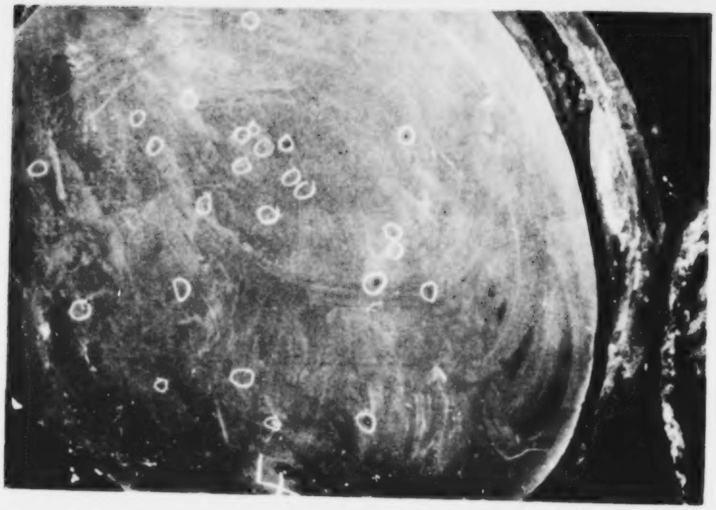


FIGURE 7

Pits 12 to 78 Mils Deep on Type 316 Deflector Plate on Venturi/Spray Tower Fourth Manway Door

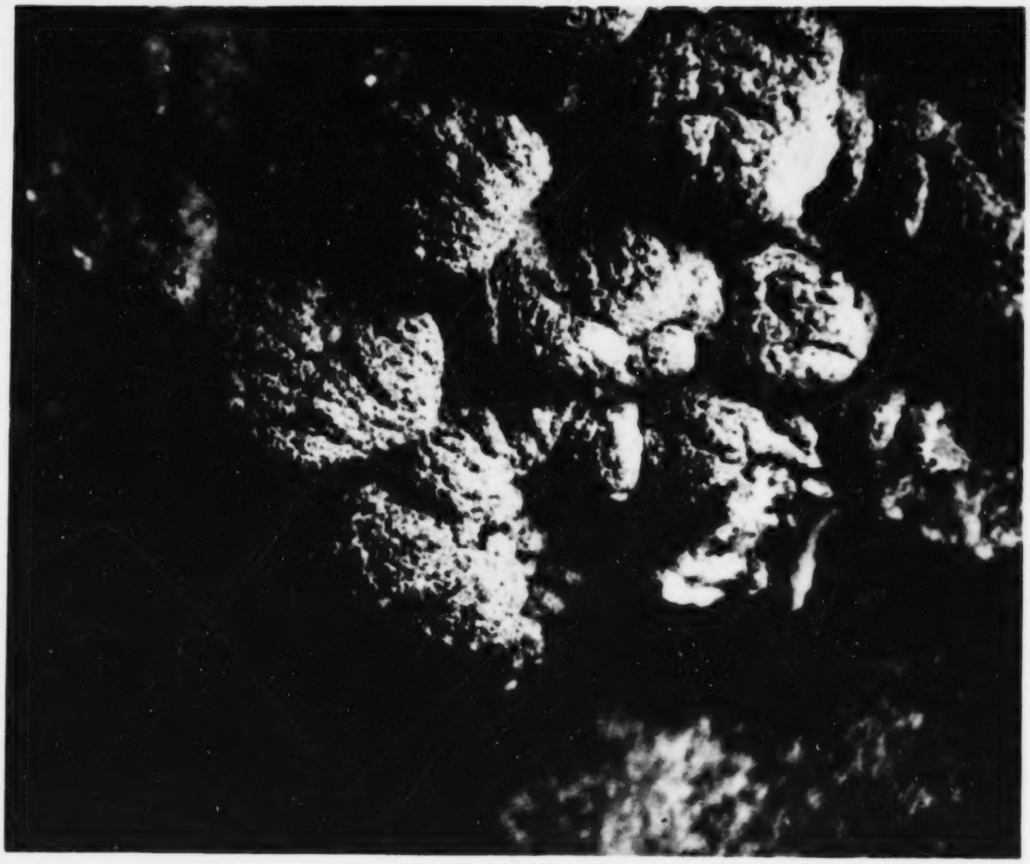


FIGURE 8

Closeup of Solids Deposited in Outlet Duct

from the Venturi/Spray Tower Reheater

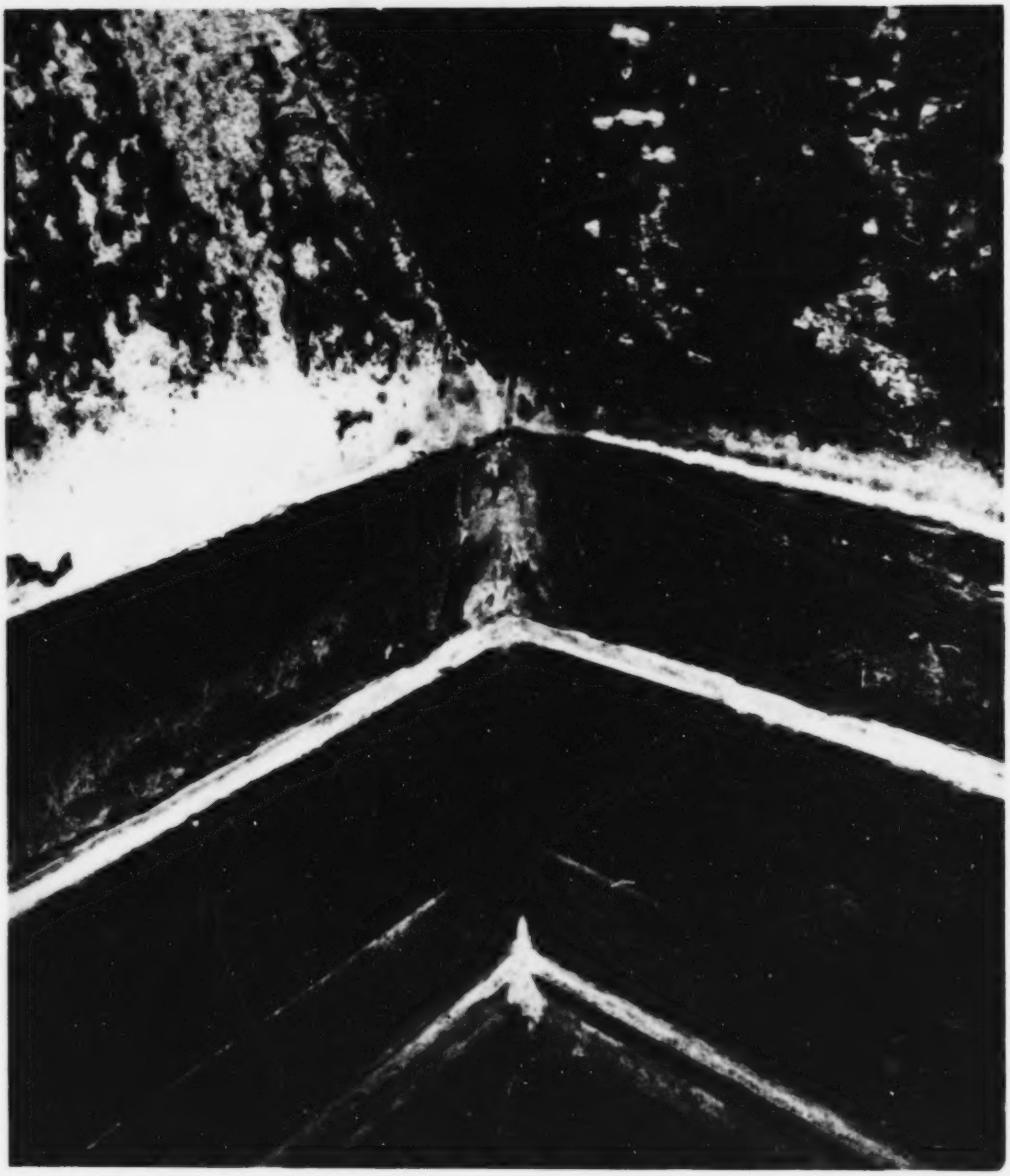


FIGURE 9

Upper Area: Transition Section from Expansion Joint to Cylindrical Stack

Lower Area: Corroded Shields That Cover Expansion Joint

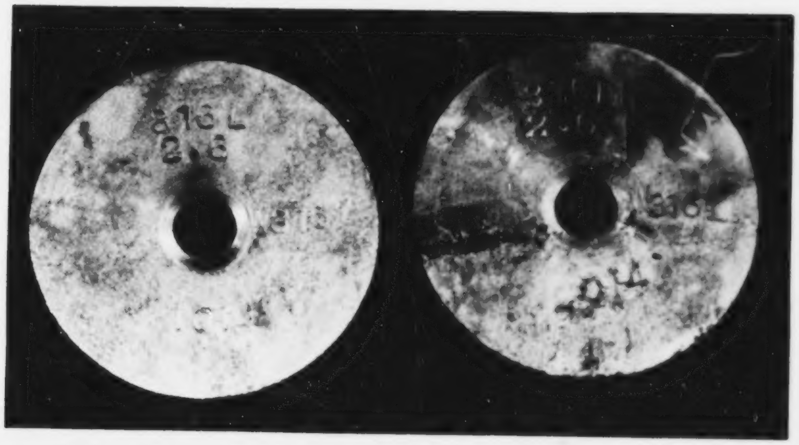
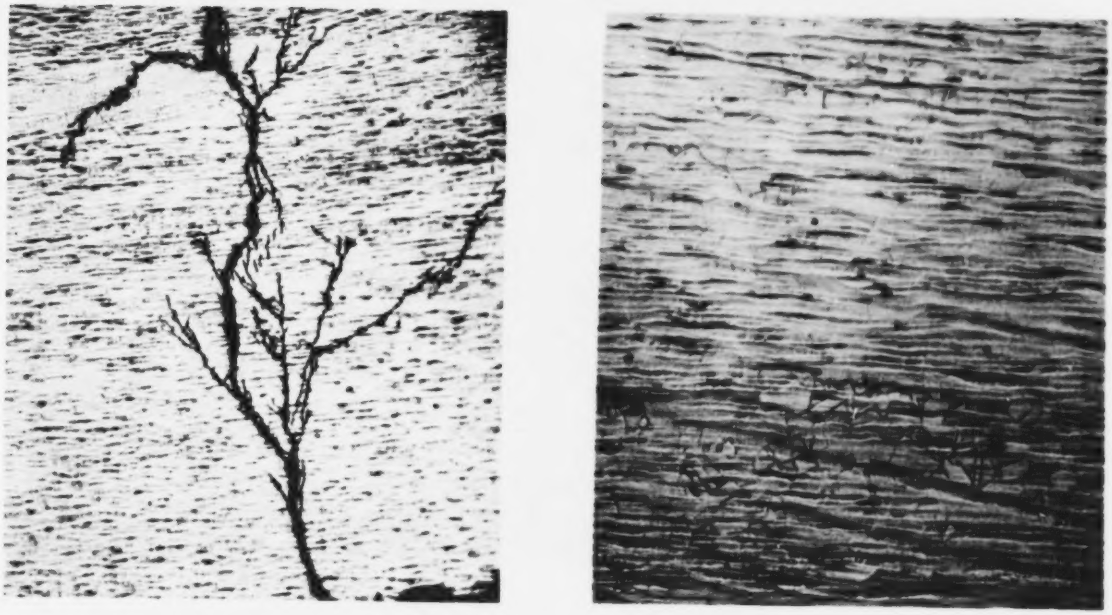


FIGURE 10

Comparative Corrosion of Type 316L Specimens Exposed at Test Locations 1014 in the Venturi/Spray Tower System and 2014 in TCA System



A. Chloride Stress-Corrosion Cracking of Bottom Half of Specimen (50X)

B. Typical Structure of Top Half of Specimen (150X)

FIGURE 11

Photomicrograph of Type 316L Specimen After Exposure at Test Location 2014 in TCA System

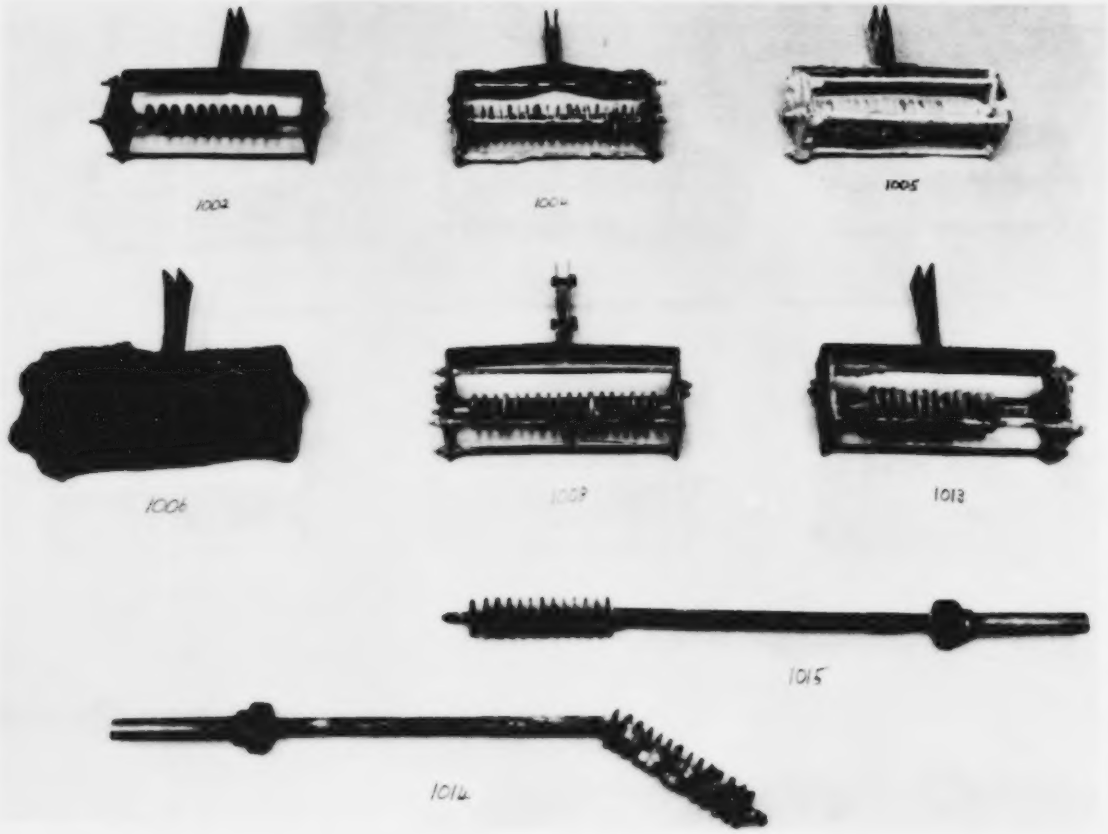

1002
1004
1005
1006
1009
1013
1015
1014

FIGURE 12

Specimens After Exposure in Venturi/Spray Tower System

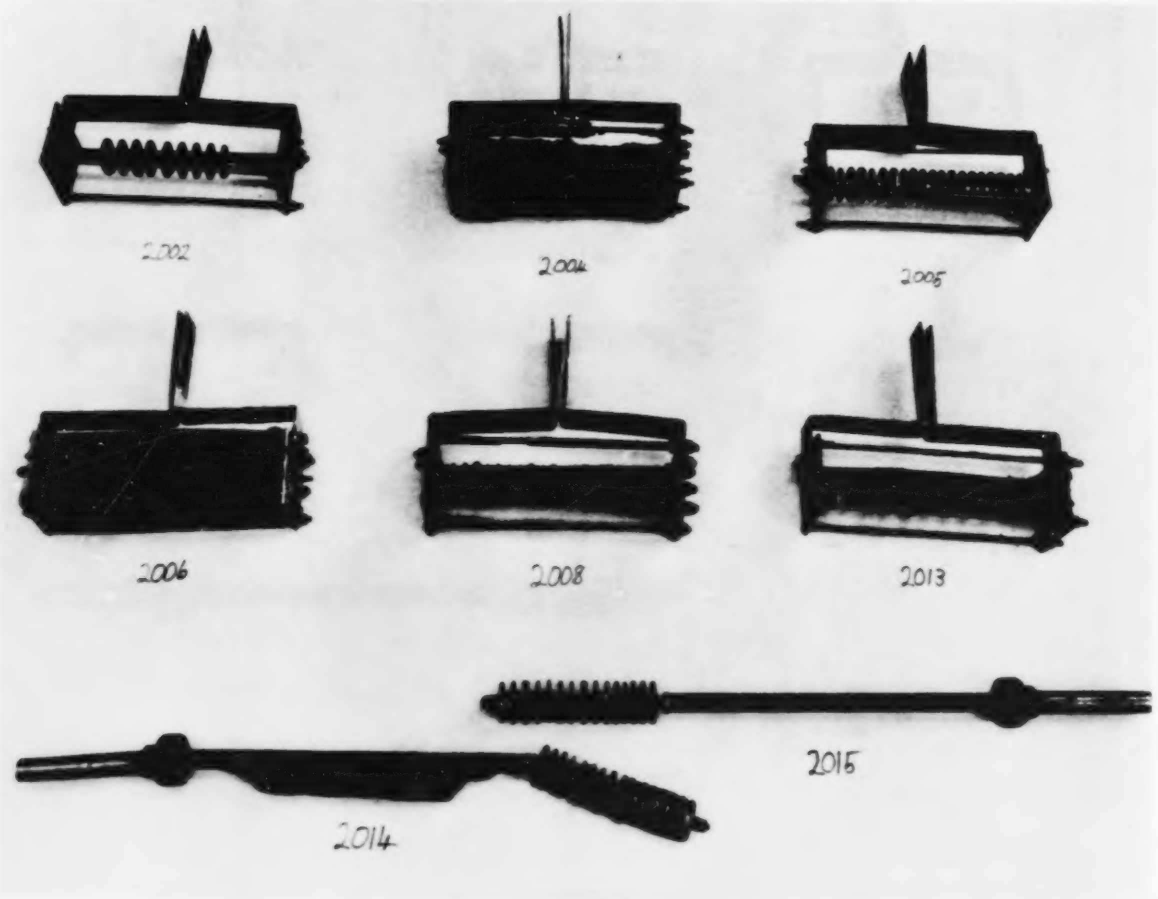
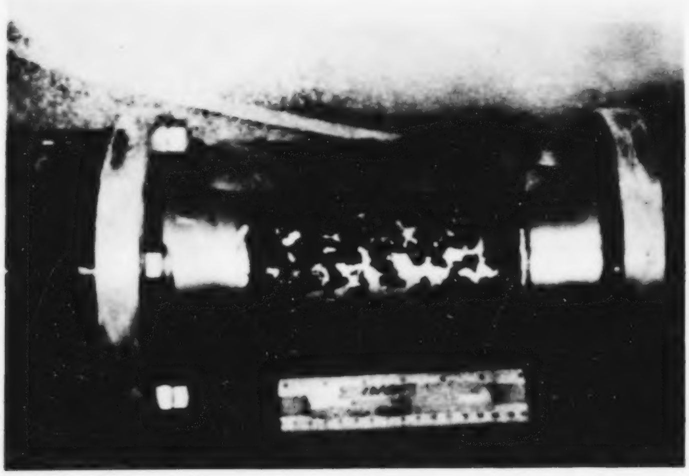
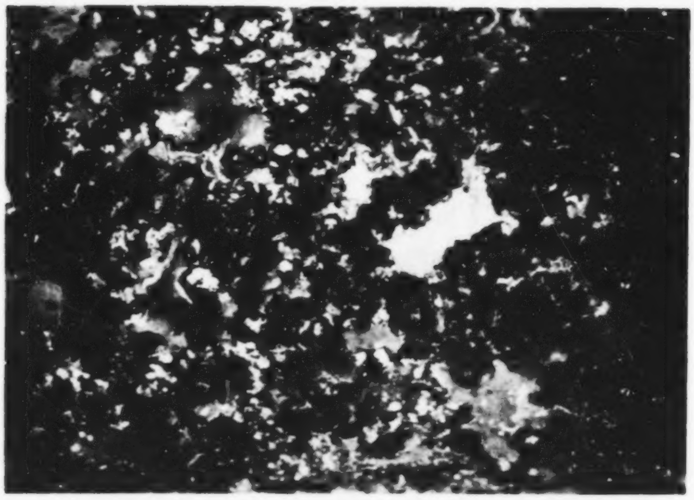

2002
2004
2005
2006
2008
2013
2015
2014

FIGURE 13

Specimens After Exposure in TCA System



A. Type 316 Flanges Forming Spool Piece



B. Closeup Showing Perforations in Pipe

FIGURE 14

Type 304, Schedule 10 Pipe That Failed with Corrosion

Rate Greater Than 420 Mils Per Year

(Venturi/Spray Tower System)

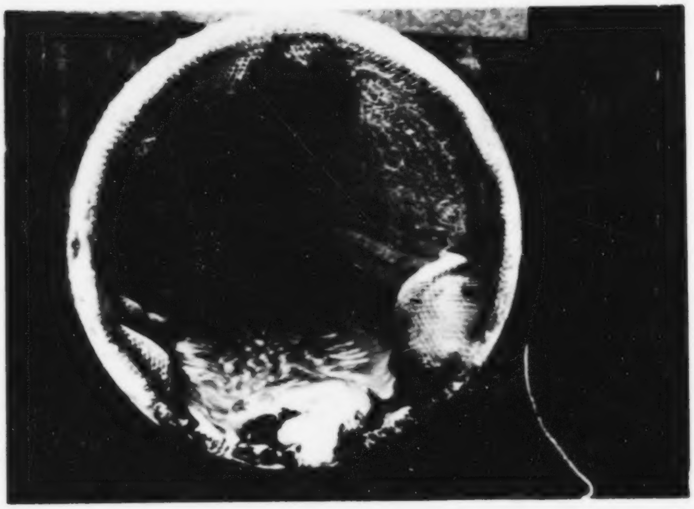


FIGURE 15

Blisters in Neoprene Lining of 6-Inch Slurry Feed Line in Venturi/Spray Tower System

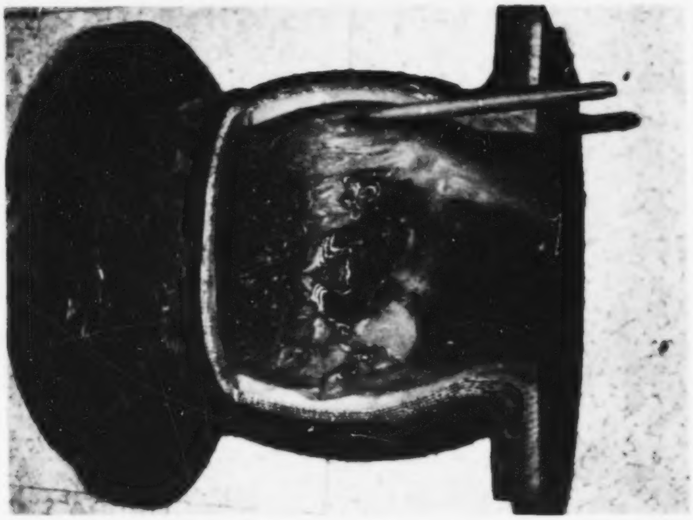


FIGURE 16

Worn Rubber Pinch Valve Used in 4-Inch Process Slurry Line to Bull Nozzle (Venturi/Spray Tower System)

APPENDIX L

TEST DATA FOR WASTE SOLIDS DEWATERING AND CHARACTERIZATION

This appendix contains detailed data for the following types of solids dewatering tests:

- Lamella settler tests
- Laboratory settling and funnel tests
- Laboratory filter leaf tests
- Hydroclone tests

Lamella Settler

Table L-1 presents the results of a long-term Lamella settler test made during venturi/spray tower Run 819-1A in November 1977. The Lamella feed was limestone bleed slurry with forced oxidation and high fly ash. Table L-1 gives flow rates and solids concentrations for the Lamella feed, overflow, and underflow.

Tables L-2 through L-5 present test results obtained with different alkali type, oxidation, and fly ash loading:

- Table L-2 - Limestone, no oxidation, high fly ash
- Table L-3 - Limestone, oxidation, low fly ash
- Table L-4 - Limestone, oxidation, high fly ash
- Table L-5 - Lime, oxidation, high fly ash

Some of these Lamella tests were made with either of two types of flocculents, Superfloc 1204 or Nalco 8861.

Table L-6 presents solids concentration profiles within the Lamella settler hold tank. Solids concentrations were obtained at nine vertical positions within the tank, with position 1 being at the top of the tank.

Table L-7 presents laboratory cylinder settling test results using bleed slurry samples taken from TCA limestone Runs 714-2A and 714-2B. These slurries were unoxidized and had high fly ash content.

The cylinder settling tests were used to obtain preliminary estimates of the maximum feed rate for the Lamella settler at differing slurry solids concentration, mass loading, flocculent concentration, and type of flocculent (if any). The estimated maximum feed rate is that at which the Lamella would be expected to have an underflow solids concentration greater than 40 weight percent and an overflow solids concentration less than 0.5 weight percent.

Laboratory Settling and Funnel Tests

Tables L-8 and L-9 present laboratory settling and funnel test data for the venturi/spray tower and TCA systems, respectively, for the period November 1976 through June 1978. The data cover:

- Limestone versus lime alkali
- Forced oxidation versus low (natural) oxidation
- Initial slurry solids concentrations of 8 and 15 weight percent
- High versus low fly ash loading
- MgO additive for some tests

The test results include the initial solids settling rate, the ultimate settled solids concentration, and the funnel test cake solids concentration.

Laboratory Filter Leaf Tests

Tables L-10 through L-13 present filter leaf test results. The best of these results are presented in Table 22-6. The filter leaf cycle time is the sum of the form (or submergence) time and the dry time, plus the cake discharge time. The initial slurry samples were obtained from the clarifier underflow of either the venturi/spray tower or the TCA. Test results presented in the tables include the cake solids concentration and thickness, the dry solids loading handled by the filter leaf, and the filtrate loading.

The filter leaf test blocks referred to in Tables L-10 through L-13 are as follows:

• Block 2: (Table L-10)	Lime, high fly ash, two-scrubber-loop forced oxidation
• Block 3: (Table L-10)	Lime, high fly ash, no forced oxidation
• Block 5: (Table L-11)	Lime, low fly ash, two-scrubber-loop forced oxidation
• Block 6: (Table L-12)	Lime, low fly ash, no forced oxidation
• Block 7: (Table L-13)	Limestone, high fly ash, one-scrubber-loop forced oxidation
• Block 8: (Table L-10)	Limestone, high fly ash, two-scrubber-loop forced oxidation

Hydroclone

Tables L-14 through L-17 present hydroclone results for three two-hour tests made during venturi/spray tower limestone Run 819-1A in November 1977. The bleed slurry fed to the hydroclone was oxidized and had high fly ash content.

The three tests were conducted with nominal hydroclone feed rates of 18, 15, and 12 gpm.

Table L-14 summarizes the operating data for all three tests. The data given include flow rates and solids concentrations for the hydroclone feed, overflow, and underflow.

Tables L-15 through L-17 list solids compositions measured during the tests with 18, 15, and 12 gpm feed rates, respectively.

Table L-1

RESULTS OF LONG-TERM LAMELLA SETTLER TEST MADE DURING NOVEMBER 1977

Date	Feed		Overflow		Underflow	
	gpm	wt%	gpm*	wt%	gpm	wt%
11/01	9.0	14.5	--	0.45	--	40
	8.0	15.6	4.6	0.06	3.4	62
11/02	9.0	14.2	4.8	0.08	4.2	36
	9.0	15.5	6.0	0.07	3.0	45
	9.0	14.2	5.4	0.06	3.6	40
11/03	9.0	15.0	5.4	0.09	3.6	40
	8.0	16.6	4.4	0.08	3.6	39
	9.0	15.8	5.4	0.08	3.6	38
11/04	8.5	15.5	5.2	0.04	3.3	40
	9.0	15.1	5.8	0.07	3.2	38
	↓	14.7	5.9	0.11	3.1	32
11/05		15.0	5.4	0.07	3.6	40
		15.4	5.7	0.09	3.3	35
		15.2	5.8	0.05	3.2	41
11/06		15.4	5.8	0.05	3.2	41
		14.5	5.6	0.05	3.4	41
		15.6	5.6	0.06	3.4	40
11/07		15.0	5.6	0.08	3.4	41
		14.1	5.8	0.10	3.2	37
		14.2	5.8	0.05	3.2	37
11/08		16.3	6.0	0.06	3.0	42
		15.0	5.8	0.08	3.2	36
		14.9	5.8	0.06	3.2	46
11/09		15.2	--	0.08	--	47
		14.3	5.8	0.06	3.2	44
		14.5	5.8	0.09	3.2	39
11/10		15.8	5.8	0.15	3.2	41
		14.6	5.8	0.18	3.2	37
		15.3	6.0	0.15	3.0	40
11/11		15.1	5.9	0.14	3.1	45
		14.3	5.8	0.09	3.2	42
		16.4	6.0	0.07	3.0	38
11/12		13.0	5.6	0.11	3.4	42
		14.4	5.6	0.07	3.4	37
		15.2	5.8	0.12	3.2	40
11/13		14.0	--	0.07	--	40
		14.2	--	0.10	--	39
		15.8	5.7	0.08	3.3	41

Table L-1 (continued)

RESULTS OF LONG-TERM LAMELLA SETTLER TEST MADE DURING NOVEMBER 1977

Date	Feed		Overflow		Underflow	
	gpm	wt%	gpm*	wt%	gpm	wt%
11/14	9.0	15.0	5.7	0.09	3.3	39
		13.0	5.7	0.08	3.3	28
		15.4	6.0	0.18	3.0	37
11/15		14.2	6.1	0.12	2.9	45
		14.8	5.8	0.01	3.2	45
		15.2	5.7	0.08	3.3	37
11/16		14.9	5.8	0.10	3.2	40
		15.3	5.9	0.10	3.1	40
		15.9	5.8	0.07	3.2	42
11/17		14.9	5.9	0.08	3.1	42
		15.2	5.7	0.09	3.3	44
		16.2	5.6	0.10	3.4	44
11/18		14.9	5.9	0.10	3.1	41
		16.2	5.9	0.09	3.1	38
		15.5	5.8	0.16	3.2	52
11/19		14.5	6.3	0.08	2.7	54
		14.7	6.2	0.08	2.8	49
		15.2	5.9	0.13	3.1	40
11/20		13.9	5.6	0.05	3.4	40
		16.1	5.6	0.07	3.4	42
		15.3	7.0	0.13	2.0	41
11/21		14.0	6.0	0.08	3.0	41
		15.4	5.9	0.07	3.1	41
		15.3	5.8	0.14	3.2	44
11/22		14.8	5.8	0.07	3.2	38
		15.5	5.7	0.09	3.3	41
		15.5	5.7	0.73	3.3	40
11/23		14.5	5.6	0.05	3.4	39
		14.1	5.6	0.07	3.4	36
		15.5	5.8	0.10	3.2	38
11/24		14.0	5.8	0.13	3.2	37
		15.2	5.8	0.06	3.2	42
		15.2	5.8	0.11	3.2	42
11/25		14.0	5.7	0.08	3.3	43
		14.4	5.7	0.09	3.3	39
		13.4	5.9	0.14	3.1	37
11/26		11.8	6.0	1.29	3.0	30
		15.6	6.1	0.21	2.9	45
		16.7	5.8	0.12	3.2	43

Table L-1 (continued)

RESULTS OF LONG-TERM LAMELLA SETTLER TEST MADE DURING NOVEMBER 1977

Date	Feed		Overflow		Underflow	
	gpm	wt%	gpm*	wt%	gpm	wt%
11/27	9.0	16.4	5.5	0.10	3.5	43
	↓	16.6	5.5	0.12	3.5	40
		17.4	5.2	0.22	3.8	39
11/28		16.3	5.3	0.08	3.7	39
		15.7	5.3	0.10	3.7	37
		14.1	5.6	0.29	3.4	37
11/29		15.2	5.7	0.12	3.3	40
		15.4	5.8	0.11	3.2	39
		15.9	5.7	0.04	3.3	41

* Overflow rate determined by difference between feed and underflow.

Table L-2

SUMMARY OF LAMELLA TESTING ON UNOXIDIZED LIMESTONE SLURRY WITH HIGH FLY ASH LOADING FROM RUNS 714-2A AND 714-2B

Duration, hrs.	Lamella Feed		Flocculent		Overflow		Underflow	
	gpm	wt%	Type	ppm	gpm	wt% solids	gpm	wt% solids
46	3.0	15 - 17	none		2.0	0.1 - 4.5	1.0	26 - 35
23	2.0	15 - 16	none		1.0	0.05 - 0.7	1.0	38 - 39
22	30 - 40	7 - 9	Superfloc 1204	8 - 12	23 - 33	0.6 - 4.3	5.5 - 7	26 - 29
16	35 - 46	7 - 8	Nalco 8861	10 - 11	37 - 40	0.1 - 0.7	7	33 - 37
1	49	7	Nalco 8861	7	42	1.4	7	35

Table L-3

SUMMARY OF LAMELLA TESTING ON OXIDIZED LIMESTONE SLURRY WITH LOW FLY ASH LOADING FROM RUN 809-1A

LAMELLA FEED			UNDERFLOW			OVERFLOW	
gpm	wt%		gpm	wt%		gpm*	wt%
6	12.4		3.5	27.8		2.5	0.11
7.5	13.8		3.6	27.3		3.9	0.07
8	16.1		3.5	33.2		4.5	0.13
10	12.9		4.0	30.3		6.0	0.06
10	12.8		3.5	40.1		6.5	0.10
10	15.3		3.9	35.5		6.1	--
11	13.8		4.1	22.4		6.9	0.45
12	14.7		4.0	40.7		8.0	0.24
12	14.8		4.5	37.8		7.5	0.25
12	13.8		4.6	43.2		7.4	0.38
12	--		3.6	39.6		8.4	0.70

* Determined by difference between Feed and Underflow.

Table L-4

SUMMARY OF LAMELLA TESTING ON OXIDIZED LIMESTONE SLURRY WITH HIGH FLY ASH LOADING FROM RUNS 803-2A, 804-2A, AND 818-2A

Duration, hrs.	Lamella Feed		Overflow		Underflow	
	gpm	wt%	gpm	wt%	gpm	wt%
26	3.0	14-16	2.2	-	0.8	41-48
24	4.0	15	2.8	0.01	1.2	38-43
24	5.7	13-16	4.2	0.02	1.5	39-46
26	9.2	14-17	6.6	0.09	2.6	37-46
18	10	15-17	7.0	0.03	3.0	43
22	12	15	8.5	0.21	3.5	35-48
19	10	14-16	6.7	0.06	3.3	34-56
1	24	14	17	1.2	7	39
1	22	15	15	0.8	7	41
18	10	15	5-6	0.03	4-5	38-60
36	20	15	11-14	0.3-0.7	6-9	42-57
8	17	15	9.6	0.20	7.4	38-46
8	20	16-17	12-14	0.3-0.6	6-8	38-43
5	18	14	10-12	0.45	6-8	41-45
10	20	15	13	0.3-0.6	7	34-46

Table L-5

SUMMARY OF LAMELLA TESTING ON OXIDIZED LIME SLURRY WITH HIGH FLY ASH LOADING FROM RUN 862-1A

Duration hrs.	Lamella Feed		Flocculant		Overflow		Underflow	
	gpm	wt%	Type	ppm	gpm	wt%	gpm	wt%
24	5.0	14.4-15.6	none		3.6-3.7	0.04-0.11	1.3-1.4	39.9-52.7
73	10.2	13.8-15.8	none		7.0-7.2	0.07-0.51	3.0-3.2	33.6-48.7
22	38-41.5	8.2-8.7	Nalco 8861	7.7-8.3	32.0-35.5	0.03-0.07	6.0	41.0-52.6

Table L-6

SUMMARY OF SOLIDS CONCENTRATION PROFILES OF LAMELLA SETTLER HOLD TANK

RUN NUMBER	809-1A	714-2A	714-2A	714-2A	714-2A	714-2A	862-1A	862-1A	717-1A
Slurry Type	LS/OX/NOFA	LS/UNOX/NOFA	LS/UNOX/NOFA	LS/UNOX/NOFA	LS/UNOX/NOFA	LS/UNOX/NOFA	LIME/FA/OX	LIME/FA/OX	LS/FA/UNOX
Flocculant conc., ppm	none	Nalco 9.8	Nalco 9.8	Nalco 9.8	Nalco 9.8	Nalco 9.8	none	Nalco 8861 8.1	none
Slurry Feed, wt%	14.5	6.6	6.6	7.0	7.0	6.8	14.4	8.1	16.1
gpm	12	36.0	44.0	44.0	46.0	45.0	10.2	39.0	2.0
Lamella Settler Overflow, wt%	0.7	0.01	0.03	0.52	0.68	0.16	0.13	0.03	6.8
gpm	8.4	30.5	37.0	37.0	39.0	38.0	7.2	33.0	1.4
Top of hold tank 1, wt%	5.0	28.9	31.7	33.3	33.7	20.2	14.3	3.1	34.9
2	5.9	28.3	30.6	34.0	31.9	34.1	13.4	11.7	36.8
3	5.9	28.5	31.3	32.2	32.5	34.4	13.3	11.8	35.3
4	3.4	28.6	30.2	33.5	32.6	34.5	13.7	11.6	35.7
5	11.9	29.0	30.0	33.1	33.0	34.5	13.7	11.3	35.5
6	5.6	29.0	30.3	33.0	31.3	35.4	13.6	10.9	36.1
7	10.5	29.0	30.3	33.8	31.1	35.6	13.6	11.7	35.2
8	6.5	29.1	32.8	33.1	34.0	35.2	13.7	11.1	36.4
Bottom of hold tank 9	6.7	29.1	31.2	33.0	34.3	35.5	13.4	19.7	35.5
Underflow, wt%	39.6	32.6	32.8	34.4	35.0	36.8	41.4	41.0	41.2
gpm	3.6	5.5	7.0(1)	7.0(1)	7.0(1)	7.0(1)	3.0	6.0	0.6

(1) Maximum attainable flow on underflow pump.

Table L-7

LABORATORY CYLINDER SETTLING TESTS

Initial Slurry Conc., wt%	Flocculent		Initial Settling Rate, cm/min	Surface Loading Rate, gpm, ft^2	Mass Loading, ton/day/ft^2	Estimated Maximum Feed Rate for the Lamella Settler, gpm(1)
	Type	Conc., ppm				
15	none		0.28	0.07	0.07	3.9
15	Superfloc 1204	5.0	0.30	0.07	0.07	3.9
15	Superfloc 1204	10.0	0.38	0.09	0.09	5.0
15	Superfloc 1204	10.0	0.46	0.11	0.11	6.3
15	Superfloc 1204	15.0	0.41	0.10	0.10	5.6
15	Superfloc 1204	25.0	0.36	0.09	0.09	5.2
15	none		0.19	0.03	0.03	1.7
15	Nalco 8861	8.0	0.19	0.05	0.05	3.1
15	Nalco 8861	12.0	0.22	0.06	0.06	3.7
15	Nalco 8861	16.0	0.22	0.08	0.07	4.3
8	none		0.94	0.19	0.10	11.0
8	Superfloc 1204	4.0	4.78	1.16	0.58	66.6
8	Superfloc 1204	8.0	4.57	1.08	0.55	62.4
8	none		0.93	0.17	0.08	9.8
8	Nalco 8861	0.5	4.98	1.82	0.92	104.6(2)
8	Nalco 8861	1.5	11.20	2.73	1.38	157.0(2)
8	Nalco 8861	3.0	16.18	3.86	1.94	222.0(2)
8	Nalco 8861	7.5	17.42	4.42	2.22	254.2(2)
8	Nalco 8861	8.0	11.20	3.06	1.54	176.0(2)
8	Nalco 8861	12.5	24.89	5.32	2.67	305.9(2)

(1) Based on 57.5 ft^2 clarification area

(2) Maximum design feed flow rate for the Lamella settler is 95 gpm.

Table L-8

SETTLING AND FUNNEL TEST RESULTS FOR THE VENTURI/SPRAY TOWER

Run No.	Date	Initial Settling Rate, cm/min	Ultimate Settled Solids, wt. %	Funnel Test Cake Solids, wt. %	Initial Solids, wt. %	Alkali	Fly Ash	Venturi Inlet pH, avg.	Sample Oxidation, mole %	Avg. Air Stoich. $\frac{\text{lb-atoms O}}{\text{lb-mole SO}_2\text{ abs.}}$
801-1A	1/ 6/77(1)	0.13	38.5	--	5.1	LS	Yes	4.5	80.4	4.7
801-1A	1/ 8/77(1)	0.11	36.4	--	6.5	LS	Yes	4.5	98.7	4.7
801-1A	1/ 9/77	0.87	66.7	--	13.3	LS	Yes	4.5	93.3	4.7
801-1A	1/15/77	0.63	71.4	69	14.8	LS	Yes	4.5	96.8	4.7
802-1A	1/25/77	1.08	71.3	71	15.8	LS	Yes	5.0	96.5	4.7
802-1A	1/26/77	1.08	63.0	71	12.9	LS	Yes	5.0	97.0	4.7
802-1A	1/27/77	0.96	72.2	70	13.8	LS	Yes	5.0	97.4	4.7
802-1A	1/28/77	1.08	76.2	73	15.3	LS	Yes	5.0	95.2	4.7
802-1A	1/29/77	1.08	74.5	72	13.6	LS	Yes	5.0	98.0	4.7
802-1A	1/30/77	1.08	80.2	72	15.7	LS	Yes	5.0	97.3	4.7
802-1A	1/31/77	1.08	80.5	67	16.8	LS	Yes	5.0	93.4	4.7
802-1A	2/ 1/77	1.31	65.5	66	10.9	LS	Yes	5.0	90.2	4.7
802-1A	2/ 2/77	1.26	73.7	65	15.8	LS	Yes	5.0	98.2	4.7
802-1A	2/ 4/77	1.26	71.1	66	14.9	LS	Yes	5.0	97.9	4.7
803-1A	2/ 5/77	1.26	69.9	60	14.5	LS	Yes	5.0	94.1	4.7
803-1A	2/ 6/77	1.08	71.1	70	14.7	LS	Yes	5.0	98.2	4.7
803-1A	2/ 7/77	1.22	79.4	72	15.8	LS	Yes	5.0	96.6	4.7
803-1A	2/ 8/77	1.22	77.4	72	15.1	LS	Yes	5.0	97.9	4.7
803-1A	2/ 9/77	1.22	74.5	73	15.3	LS	Yes	5.0	97.4	4.7
803-1A	2/10/77	1.41	76.3	72	15.9	LS	Yes	5.0	97.7	4.7
804-1A	2/11/77	1.22	80.1	74	16.4	LS	Yes	5.0	96.7	4.4
804-1A	2/12/77	1.22	78.5	74	16.1	LS	Yes	5.0	97.3	4.4
804-1A	2/13/77	1.08	78.5	72	15.1	LS	Yes	5.0	98.2	4.4
804-1A	2/14/77	1.02	74.0	73	15.9	LS	Yes	5.0	97.8	4.4
804-1A	2/16/77	1.15	75.5	66	17.1	LS	Yes	5.0	97.8	4.4
804-1A	2/17/77	1.05	75.6	67	15.1	LS	Yes	5.0	86.0	4.4
804-1A	2/18/77	1.05	75.1	66	16.6	LS	Yes	5.0	--	4.4
805-1A	2/19/77	1.08	73.8	67	13.4	LS	Yes	5.0	99.9	3.7
805-1A	2/20/77	1.02	72.6	64	13.6	LS	Yes	5.0	98.5	3.7
805-1A	2/21/77	1.02	74.1	72	15.6	LS	Yes	5.0	97.8	3.7
805-1A	2/22/77	1.41	69.9	71	13.8	LS	Yes	5.0	90.1	3.7
805-1A	2/23/77	1.08	59.3	72	11.0	LS	Yes	5.0	96.6	3.7
806-1A	2/24/77	0.61	68.9	69	13.3	LS	Yes	4.5	99.9	2.5
806-1A	2/25/77	0.54	73.0	67	14.8	LS	Yes	4.5	97.1	2.5
806-1B	2/26/77	0.81	66.0	69	13.1	LS	Yes	4.5	97.7	1.7
806-1B	2/27/77	0.81	73.2	73	15.6	LS	Yes	4.5	97.2	1.7
806-1C	2/28/77	0.70	66.8	70	14.1	LS	Yes	4.5	91.4	1.0
806-1C	3/ 1/77	0.61	71.1	71	14.5	LS	Yes	4.5	99.9	1.0
806-1D	3/ 2/77	0.57	68.6	79	13.7	LS	Yes	4.5	71.1	0.5
806-1D	3/ 3/77	0.47	65.7	64	13.9	LS	Yes	4.5	50.1	0.5

Table L-8 (continued)

SETTLING AND FUNNEL TEST RESULTS FOR THE VENTURI/SPRAY TOWER

Run No.	Date	Initial Settling Rate, cm/min	Ultimate Settled Solids, wt.%	Funnel Test Cake Solids, wt.%	Initial Solids, wt.%	Alkali	Fly Ash	Venturi Inlet pH, avg.	Sample Oxidation, mole %	Avg. Air Stoich. $\frac{\text{lb-atoms O}}{\text{lb-mole SO}_2\text{ abs.}}$
807-1A	3/ 4/77	0.34	63.1	59	14.8	LS	Yes	4.5	19.6	0
807-1A	3/ 5/77	0.47	59.8	70	12.9	LS	Yes	4.5	12.8	0
807-1A	3/ 6/77	0.54	67.2	65	15.8	LS	Yes	4.5	6.6	0
808-1A	3/ 7/77	0.61	76.2	65	15.3	LS	Yes	4.5	96.9	1.7
808-1A	3/ 8/77	0.62	71.6	65	15.9	LS	Yes	4.5	99.3	1.7
851-1A	8/11/77	0.70	75.8	63	19.6	L	Yes	4.5	66.0	1.45
851-1A	3/12/77	1.31	70.9	64	13.4	L	Yes	4.5	97.8	1.45
851-1A	3/13/77	0.69	76.7	64	15.7	L	Yes	4.5	96.7	1.45
851-1A	3/14/77	1.31	76.7	64	15.7	L	Yes	4.5	99.5	1.45
852-1A	3/16/77	0.81	82.8	70	21.5	L	Yes	5.6	72.7	1.55
852-1A	3/17/77	0.20	62.6	59	16.3	L	Yes	5.6	87.1	1.55
852-1A	3/18/77	0.12	56.3	60	15.3	L	Yes	5.6	36.1	1.55
853-1A	3/19/77	0.57	71.3	63	16.0	L	Yes	4.8	69.3	1.40
853-1A	3/20/77	0.96	81.7	64	17.0	L	Yes	4.8	91.5	1.40
853-1A	3/21/77	0.99	80.9	--	16.3	L	Yes	4.8	93.9	1.40
853-1A	3/22/77	0.96	80.2	64	16.7	L	Yes	4.8	95.1	1.40
853-1A	3/23/77	0.99	79.1	70	16.3	L	Yes	4.8	95.3	1.40
853-1A	3/24/77	1.18	76.1	71	14.1	L	Yes	4.8	94.9	1.40
853-1A	3/25/77	0.96	62.5	71	12.9	L	Yes	4.8	86.0	1.40
854-1A	3/26/77	1.05	77.1	70	15.6	L	Yes	5.2	98.7	1.40
854-1A	3/27/77	0.85	84.7	70	15.6	L	Yes	5.2	95.7	1.40
854-1A	3/28/77	0.85	78.3	72	15.1	L	Yes	5.2	94.0	1.40
854-1A	3/29/77	0.11	60.1	69	16.9	L	Yes	5.2	93.5	1.40
854-1A	3/30/77	0.92	73.6	71	16.6	L	Yes	5.2	94.2	1.40
854-1A	3/31/77	1.02	73.0	65	14.8	L	Yes	5.2	98.9	1.40
854-1A	4/ 1/77	1.02	75.0	70	15.8	L	Yes	5.2	98.1	1.40
855-1A	6/23/77	0.46	60.0	66	15.0	L	No	4.7	44.5	1.90
856-1A	7/ 7/77$^{(1)}$	0.18	34.6	38	7.7	L	No	5.0	11.3	1.65
856-1A	7/ 7/77	1.67	86.6	72	15.1	L	No	5.0	98.2	1.65
857-1A	7/ 8/77$^{(1)}$	0.18	36.7	43	7.7	L	No	5.5	11.8	1.65
857-1A	7/ 8/77	2.44	80.4	81	14.2	L	No	5.5	95.7	1.65
857-1A	7/12/77$^{(1)}$	0.18	37.9	61	8.6	L	No	5.5	10.2	1.65
857-1A	7/12/77	1.53	72.6	73	18.3	L	No	5.5	98.4	1.65
858-1A	7/15/77	1.67	73.9	82	7.6	L	No	5.5	91.1	1.60
858-1A	7/15/77$^{(2)}$	0.92	81.2	--	~15.0	L	No	5.5	91.1	1.60
858-1A	7/17/77	2.44	64.1	77	6.5	L	No	5.5	99.0	1.60
858-1A	7/17/77$^{(2)}$	0.92	60.0	--	~15.0	L	No	5.5	99.0	1.60
858-1A	7/19/77	2.62	65.9	85	7.3	L	No	5.5	97.9	1.60
858-1A	7/19/77$^{(2)}$	1.22	56.9	--	~14.5	L	No	5.5	97.9	1.60

Table L-8 (continued)

SETTLING AND FUNNEL TEST RESULTS FOR THE VENTURI/SPRAY TOWER

Run No.	Date	Initial Settling Rate, cm/min	Ultimate Settled Solids, wt.%	Funnel Test Cake Solids, wt.%	Initial Solids, wt.%	Alkali	Fly Ash	Venturi Inlet pH, avg.	Sample Oxidation, mole, %	Avg. Air Stoich. $\frac{\text{lb-atoms O}}{\text{lb-mole } SO_2 \text{ abs.}}$
859-1A	7/23/77	0.16	57.5	71	13.7	L	No	5.5	84.3	1.20
859-1A	7/24/77	0.15	65.8	68	15.3	L	No	5.5	79.7	1.20
859-1B	7/26/77	0.83	68.5	83	14.4	L	No	5.5	96.6	1.50
859-1B	7/27/77(1)	0.14	34.4	40	7.5	L	No	5.5	10.0	1.50
859-1B	7/27/77	0.73	66.5	67	13.7	L	No	5.5	99.2	1.50
859-1B	7/28/77	0.73	71.5	68	14.0	L	No	5.5	99.3	1.50
859-1C	7/29/77	0.73	66.8	64	15.2	L	No	5.5	92.0	1.0
859-1C	7/30/77	0.10	58.0	59	15.7	L	No	5.5	66.9	1.0
859-1C	7/31/77	0.10	56.1	62	15.0	L	No	5.5	64.2	1.0
859-1C	8/ 1/77	0.13	60.0	59	15.1	L	No	5.5	81.1	1.0
859-1C	8/ 2/77	0.12	57.7	66	15.6	L	No	5.5	70.4	1.0
859-1D	8/ 3/77	0.05	47.6	52	15.4	L	No	5.5	30.4	0
859-1D	8/ 4/77	0.05	34.1	51	14.5	L	No	5.5	25.9	0
859-1D	8/ 5/77	0.05	44.9	48	14.7	L	No	5.5	30.2	0
859-1D	8/ 6/77	0.10	58.0	66	16.8	L	No	5.5	52.5	0
860-1A	8/ 7/77	0.45	66.8	79	13.8	L	No	5.5	98.2	1.75
860-1A	8/ 8/77	0.63	75.9	78	15.2	L	No	5.5	98.2	1.75
860-1A	8/ 9/77	0.68	70.2	80	14.4	L	No	5.5	98.2	1.75
860-1A	8/10/77	0.81	75.3	73	15.0	L	No	5.5	98.5	1.75
860-1A	8/11/77	0.65	66.0	82	13.1	L	No	5.5	98.2	1.75

(1) Sample from spray tower slurry loop.

(2) These were originally at 8 percent initial solids. They were concentrated to 15 percent solids so the results could be compared with other runs.

The settling test was performed in a 500 ml cylinder instead of the normal 1000 ml cylinder due to small sample size when the sample was concentrated to 15 percent.

Table L-8 (continued)

SETTLING AND FUNNEL TEST RESULTS FOR THE VENTURI/SPRAY TOWER

Run Number	Date	Initial Settling Rate, cm/min	Ultimate Settled Solids, wt%	Funnel Test Cake Solids, wt%	Initial Solids, wt%	Alkali	Fly Ash	Venturi Inlet pH	Sample Oxidation, mole %	Avg. Air Stoich. $\frac{\text{lb-atoms O}}{\text{lb-mole SO}_2\text{ abs.}}$
809-1A	8/13/77	0.80	70.4	80.7	12.4	LS	No	4.7	96.9	1.88
	8/14/77	0.61	67.3	79.0	13.0	LS	No	4.4	98.5	1.92
	8/15/77	0.83	85.8	75.4	16.0	LS	No	4.5	95.4	1.71
	8/17/77	0.73	80.6	77.9	17.1	LS	No	4.5	99.0	1.70
810-1A	8/19/77	0.87	94.1	75.7	18.8	LS	No	--	98.9	1.57
	8/21/77	0.89	79.0	77.3	16.5	LS	No	4.9	95.2	1.29
	8/24/77	1.08	79.3	82.1	14.0	LS	No	4.9	97.9	2.07
	8/25/77	1.15	73.5	76.8	13.3	LS	No	5.0	99.0	1.77
811-1A	8/27/77	0.96	81.6	79.0	14.6	LS	No	5.4	99.2	1.73
	8/31/77	0.63	75.8	72.0	16.3	LS	No	5.6	79.0	1.57
812-1A	9/4/77	1.01	69.9	66.2	14.1	LS	No	5.2	95.9	1.80
	9/5/77	0.97	77.9	61.6	16.0	LS	No	6.1	98.9	1.80
	9/7/77	1.10	77.8	66.8	16.1	LS	No	5.6	98.9	1.59
814-1A	9/11/77	0.98	61.3	73.2	12.4	LS	No	5.5	95.1	1.53
	9/13/77	1.10	76.3	75.5	15.9	LS	No	5.5	96.8	1.76
	9/15/77	0.92	70.2	74.7	14.4	LS	No	5.3	100.0	1.62
	9/17/77	0.63	70.7	72.7	15.6	LS	No	6.1	99.6	1.75
	9/19/77	0.71	76.3	74.3	15.3	LS	No	6.1	97.5	1.53
815-1A	9/21/77	0.61	69.9	70.7	14.8	LS	No	6.2	97.3	1.83
	9/22/77	0.77	--	74.6	17.1	LS	No	5.2	98.1	1.62
	9/24/77	0.82	70.8	73.6	14.1	LS	No	5.9	98.3	1.78
	9/27/77	0.97	65.9	74.8	13.8	LS	No	5.2	98.9	1.56
816-1A	9/29/77	0.92	74.7	73.5	13.9	LS	No	5.1	96.6	1.56
	10/1/77	0.92	66.0	61.8	14.2	LS	No	5.4	92.8	1.83
	10/4/77	1.00	69.0	60.5	15.5	LS	No	5.3	98.6	1.57
861-1A	10/7/77	1.04	--	60.6	13.7	L	No	5.4	99.0	1.59
	10/9/77	0.79	77.7	61.4	14.6	L	No	5.2	98.7	1.59
	10/10/77	0.99	68.1	76.3	14.9	L	No	5.3	99.2	1.35
862-1A	10/12/77	1.10	68.1	78.5	14.5	L	Yes	5.3	98.4	1.74
	10/14/77	1.20	65.9	73.1	14.9	L	Yes	5.5	98.7	1.57
	10/16/77	1.01	61.0	69.4	14.5	L	Yes	5.5	99.1	1.71
817-1A	10/18/77	1.01	66.2	72.5	15.0	LS	Yes	4.8	75.8	1.62
	10/20/77	1.01	65.8	72.1	15.0	LS	Yes	5.6	97.8	1.51
	10/22/77	0.94	68.6	65.9	16.3	LS	Yes	5.6	97.6	1.92
	10/24/77	1.33	66.4	68.8	15.5	LS	Yes	5.6	99.4	1.84
	10/26/77	1.04	70.2	67.9	16.4	LS	Yes	5.5	98.0	1.55

Table L-8 (continued)

SETTLING AND FUNNEL TEST RESULTS FOR THE VENTURI/SPRAY TOWER

Run Number	Date	Initial Settling Rate, cm/min	Ultimate Settled Solids, wt%	Funnel Test Cake Solids, wt%	Initial Solids, wt%	Alkali	Fly Ash	Venturi inlet pH	Sample Oxidation mole %	Avg. Air Stoich. $\frac{\text{lb-atoms O}}{\text{lb-mole SO}_2\text{ abs.}}$
818-1A	10/27/77	1.04	77.8	65.4	14.4	LS	Yes	5.6	97.6	1.63
	10/29/77	1.05	71.7	68.6	14.9	LS	Yes	5.6	97.0	1.41
	10/30/77	1.23	68.8	66.3	16.1	LS	Yes	5.5	97.1	1.82
	11/01/77	1.33	62.0	80.4	14.0	LS	Yes	5.3	99.6	1.39
819-1A	11/03/77	1.10	65.7	90.5	15.0	LS	Yes	5.4	98.2	2.23
	11/05/77	1.35	68.4	84.2	15.0	LS	Yes	5.5	99.2	1.68
	11/07/77	1.29	75.1	71.3	15.5	LS	Yes	5.3	99.0	1.71
	11/09/77	1.29	70.5	70.5	15.3	LS	Yes	6.0	99.7	1.80
	11/11/77	1.17	66.5	65.1	15.1	LS	Yes	5.3	98.8	1.41
	11/13/77	0.96	66.8	65.6	15.2	LS	Yes	5.5	96.4	1.58
	11/15/77	1.10	68.0	65.0	14.2	LS	Yes	5.4	98.3	1.48
	11/17/77	1.08	64.0	65.3	14.7	LS	Yes	5.4	89.5	1.46
	11/19/77	0.95	66.1	73.3	14.5	LS	Yes	5.7	99.3	1.46
	11/21/77	1.10	74.9	73.5	16.2	LS	Yes	5.4	99.1	1.54
	11/22/77	1.41	70.8	73.7	14.8	LS	Yes	5.5	97.7	1.40
	11/23/77	1.01	68.9	73.2	14.5	LS	Yes	5.4	97.6	2.26
	11/24/77	1.35	81.8	72.7	14.0	LS	Yes	5.4	99.2	1.51
	11/28/77	1.13	65.3	73.8	16.3	LS	Yes	5.5	98.9	1.29
	12/2/77	0.98	76.2	71.6	15.9	LS	Yes	5.3	98.3	1.42
	12/5/77	1.07	73.5	70.1	16.8	LS	Yes	5.5	99.2	1.37
	12/6/77	1.00	75.6	71.3	15.1	LS	Yes	5.5	96.8	1.44
	12/7/77	1.10	75.4	76.0	16.9	LS	Yes	5.4	99.6	1.65
819-1B	12/13/77	1.20	65.9	74.1	14.7	LS	Yes	5.5	98.1	1.53
	12/14/77	1.15	74.7	74.5	14.8	LS	Yes	5.3	98.8	2.24
863-1A	12/17/77	0.88	65.8	72.6	16.2	L	Yes	6.0	96.5	2.41
	12/19/77	0.77	70.2	75.4	16.4	L	Yes	5.7	98.3	4.17
	12/21/77	0.79	61.3	75.1	15.4	L	Yes	5.7	98.6	1.45
	12/22/77	0.92	67.7	76.1	15.7	L	Yes	5.7	98.5	1.33
	12/26/77	1.01	64.4	74.9	15.7	L	Yes	5.8	95.6	1.49
	12/29/77	1.05	80.2	72.1	15.7	L	Yes	5.6	98.6	1.45
	12/31/77	1.10	69.6	72.1	15.2	L	Yes	5.3	99.2	1.49
	1/02/78	1.22	73.2	69.5	15.2	L	Yes	5.5	97.7	1.33
	1/04/78	1.23	73.2	72.1	17.0	L	Yes	5.7	98.1	1.50
	1/06/78	1.43	80.8	73.2	15.0	L	Yes	5.7	99.0	1.49
	1/08/78	1.38	69.9	63.9	13.3	L	Yes	5.4	88.4	1.62
	1/10/78	0.92	83.6	77.9	16.6	L	Yes	5.6	99.2	1.84
	1/11/78	0.92	65.3	70.7	13.8	L	Yes	5.6	99.6	1.95
	1/14/78	0.95	74.1	74.4	14.6	L	Yes	5.5	98.2	1.70
	1/15/78	1.01	70.2	70.5	16.4	L	Yes	7.8	16.6	1.97
	1/17/78	0.92	65.5	74.8	13.4	L	Yes	5.6	97.6	--
	1/19/78	0.99	71.7	72.0	14.9	L	Yes	5.5	98.3	1.80

Table L-8 (continued)

SETTLING AND FUNNEL TEST RESULTS FOR THE VENTURI/SPRAY TOWER

Run No.	Date	Initial Settling Rate, cm/min	Ultimate Settled Solids, wt.%	Funnel Test Cake Solids, wt.%	Initial Solids, wt.%	Alkali	Fly Ash Loading	Venturi Inlet pH	Sample Oxidation mole%	Air Stoich. $\frac{\text{lb-atoms O}}{\text{lb-mole SO}_2\text{ abs.}}$	Average Effective Magnesium, ppm
864-1A	1/21/78	0.92	60.4	72.8	13.9	L	HIGH	5.5	97.1	1.61	-
	1/23/78	1.07	64.0	75.0	15.8	L	HIGH	5.6	94.8	1.90	-
865-1A	2/5/78	0.77	63.4	--	17.0	L	HIGH	5.2	98.8	1.75	-
	2/6/78	0.61	55.2	--	14.0	L	HIGH	5.5	95.3	2.03	-
	2/7/78	0.48	55.3	62.0	14.7	L	HIGH	5.9	69.7	1.52	-
	2/8/78	1.23	81.6	72.9	17.2	L	HIGH	5.4	98.2	1.55	-
	2/10/78	0.92	55.7	72.9	14.5	L	HIGH	5.7	93.0	2.47	-
	2/11/78	0.78	62.4	69.2	15.4	L	HIGH	5.6	97.7	2.26	-
	2/12/78	1.02	64.0	70.9	15.5	L	HIGH	5.6	94.7	2.53	-
	2/14/78	1.05	61.0	71.9	15.3	L	HIGH	5.6	98.4	3.20	-
866-1A	2/16/78	0.97	62.2	73.4	14.9	L	HIGH	5.4	99.5	4.39	-
	2/17/78	0.99	73.5	74.5	14.4	L	HIGH	5.6	99.0	4.00	-
	2/18/78	0.88	67.4	72.7	14.9	L	HIGH	5.4	98.1	2.92	-
	2/19/78	0.50	59.9	70.4	16.8	L	HIGH	5.0	87.9	2.16	-
	2/20/78	0.12	58.6	67.2	16.3	L	HIGH	5.6	62.9	3.16	-
867-1A	2/23/78	0.98	70.8	78.1	14.6	L	HIGH	5.5	99.7	1.48	-
	2/27/78	1.53	77.1	89.2	15.6	L	HIGH	5.7	96.0	4.65	-
820-1A	3/3/78	1.19	65.0	75.5	12.8	LS	HIGH	5.8	99.5	3.18	8000
	3/5/78	1.02	57.7	69.6	11.5	LS	HIGH	5.4	99.5	2.28	8000
	3/19/78	1.84	60.7	61.3	13.2	LS	HIGH	5.3	98.3	2.93	8000
	3/20/78	0.23	66.1	70.6	16.3	LS	HIGH	4.8	98.6	1.58	8000
	3/22/78	1.10	80.5	45.9	11.6	LS	HIGH	6.4	99.7	3.43	8000
	3/26/78	0.32	68.6	72.5	16.8	LS	HIGH	4.9	99.4	1.84	8000
	3/27/78	0.61	64.0	71.3	16.4	LS	HIGH	5.1	88.2	1.44	8000
	3/31/78	0.36	66.2	62.6	12.2	LS	HIGH	5.2	98.5	1.64	8000
	4/1/78	0.76	66.8	74.0	15.2	LS	HIGH	5.6	99.1	2.14	8000
	4/2/78	0.78	66.2	75.0	15.0	LS	HIGH	6.4	98.3	1.98	8000
820-1B	4/5/78	0.18	33.1	71.9	7.5	LS	HIGH	5.4	72.9	0.93	8000
	4/7/78	0.18	73.3	71.9	14.9	LS	HIGH	5.2	92.8	1.08	8000
	4/8/78	0.28	80.0	71.7	16.0	LS	HIGH	5.0	87.6	1.09	8000
	4/9/78	0.40	64.6	75.7	14.0	LS	HIGH	5.3	94.8	1.40	8000
820-1C	4/14/78	0.07	55.7	57.2	16.9	LS	HIGH	5.6	31.3	--	8000
	4/15/78	0.09	46.6	58.5	17.1	LS	HIGH	4.7	49.6	--	8000
	4/16/78	0.09	40.8	53.0	15.2	LS	HIGH	4.7	30.7	--	8000
821-1A	4/20/78	0.56	58.3	74.1	13.2	LS	HIGH	5.6	97.5	5.16	8000
	4/22/78	0.96	61.4	74.5	13.0	LS	HIGH	5.4	98.5	4.78	8000
	4/23/78	0.93	72.0	75.6	13.4	LS	HIGH	5.5	96.7	10.2	8000
822-1A	4/26/78	0.72	59.4	74.3	12.0	LS	HIGH	5.6	95.4	1.54	8000
	4/27/78	0.18	72.1	74.2	17.1	LS	HIGH	5.2	97.1	1.31	8000
	4/29/78	0.26	71.1	70.0	14.2	LS	HIGH	4.9	86.9	1.31	8000
	4/30/78	0.22	61.3	70.8	15.8	LS	HIGH	5.1	89.5	1.44	8000
	5/3/78	0.26	72.8	71.8	13.1	LS	HIGH	4.9	99.0	1.53	8000
	5/4/78	0.15	71.1	64.4	15.2	LS	HIGH	5.0	96.4	1.39	8000
822-1B	5/8/78	0.18	71.1	72.8	14.7	LS	HIGH	5.3	97.7	1.76	8000
	5/9/78	0.10	75.4	72.2	13.9	LS	HIGH	4.5	98.3	1.78	8000

Table L-8 (continued)

SETTLING AND FUNNEL TEST RESULTS FOR THE VENTURI/SPRAY TOWER

Run No.	Date	Initial Settling Rate, cm/min	Ultimate Settled Solids, wt.%	Funnel Test Cake Solids, wt.%	Initial Solids, wt.%	Alkali	Fly Ash Loading	Venturi Inlet pH	Sample Oxidation, mole %	Air Stoich., $\frac{\text{lb-atoms O}}{\text{lb-mole SO}_2\text{ abs.}}$	Average Effective Magnesium, ppm
823-1A	5/13/78	0.77	64.9	-	7.6	LS	HIGH	6.8	95.7	1.68	5000
	5/14/78	0.37	72.8	-	10.3	LS	HIGH	6.0	98.0	1.87	5000
	5/15/78	0.29	77.1	-	13.2	LS	HIGH	5.5	95.9	2.16	5000
	5/16/78	0.37	59.8	-	17.9	LS	HIGH	6.5	98.5	1.62	5000
	5/17/78	0.29	65.2	75.7	17.1	LS	HIGH	6.3	96.9	1.54	5000
	5/20/78	0.46	60.8	73.6	15.6	LS	HIGH	6.2	98.1	1.58	5000
	5/21/78	0.46	39.9	72.1	6.3	LS	HIGH	6.3	91.8	1.57	5000
	5/22/78	0.42	68.3	73.5	16.2	LS	HIGH	6.4	98.6	1.54	5000
	5/23/78	0.46	62.7	73.7	15.9	LS	HIGH	6.4	97.3	1.58	5000
824-1A	5/24/78	0.55	77.4	72.6	18.6	LS	HIGH	6.3	98.3	1.77	5000
	5/25/78	0.35	72.1	72.9	20.1	LS	HIGH	6.1	99.2	1.86	5000
	5/26/78	0.55	74.9	73.1	20.1	LS	HIGH	5.9	94.7	1.40	5000
	5/27/78	0.38	62.1	73.3	20.2	LS	HIGH	6.0	99.0	1.65	5000
	5/28/78	0.37	78.8	72.3	16.2	LS	HIGH	5.9	96.4	1.67	5000
	5/29/78	0.31	67.7	74.6	19.9	LS	HIGH	5.9	98.7	1.75	5000
	5/30/78	0.32	75.2	73.2	21.5	LS	HIGH	5.9	97.3	1.45	5000
825-1A	5/31/78	0.53	74.4	74.4	18.0	LS	HIGH	5.9	98.9	1.68	5000
	6/1/78	0.50	84.5	74.8	18.3	LS	HIGH	6.0	98.0	1.71	5000
	6/2/78	0.46	75.2	73.1	18.3	LS	HIGH	5.8	96.1	1.36	5000
	6/3/78	0.50	71.0	72.4	15.5	LS	HIGH	5.8	97.7	1.49	5000
	6/5/78	0.61	76.1	72.8	14.7	LS	HIGH	5.5	99.5	1.68	5000
	6/6/78	0.46	71.3	73.5	15.3	LS	HIGH	5.6	96.9	1.53	5000
	6/7/78	0.44	89.1	72.5	18.7	LS	HIGH	5.4	99.0	1.66	5000
	6/8/78	0.35	61.6	70.7	14.7	LS	HIGH	5.4	93.0	1.58	5000
826-1A	6/11/78	0.42	70.7	73.0	16.1	LS	HIGH	5.3	97.4	--	5000
	6/13/78	0.35	70.5	70.9	14.5	LS	HIGH	5.5	99.5	--	5000
	6/14/78	0.38	61.8	75.2	15.6	LS	HIGH	5.4	97.3	--	5000
	6/15/78	0.37	63.7	73.3	14.6	LS	HIGH	5.2	95.8	1.29	5000
	6/16/78	0.31	65.7	70.8	16.6	LS	HIGH	5.4	87.5	1.35	5000
	6/17/78	0.37	76.6	71.6	16.6	LS	HIGH	5.4	95.7	1.33	5000
	6/18/78	0.60	74.4	72.9	16.9	LS	HIGH	5.7	97.8	1.40	5000
	6/19/78	0.46	94.6	80.9	17.6	LS	HIGH	5.5	96.0	1.52	5000

Table L-9

SETTLING AND FUNNEL TEST RESULTS FOR THE TCA

Run No.	Date	Initial Settling Rate, cm/min	Ultimate Settled Solids, wt.%	Funnel Test Cake Solids, wt.%	Initial Solids, wt.%	Alkali	Fly Ash	TCA Inlet pH, avg.	Sample Oxidation, mole %	Avg. Air Stoich. $\frac{\text{lb-atoms O}}{\text{lb-mole } SO_2 \text{ abs.}}$
701-2A	11/29/76	0.13	38.5	40	8.0	LS	No	5.8	6.8	0
701-2A	11/30/76	0.08	33.6	42	8.3	LS	No	5.8	28.9	0
701-2A	12/ 2/76	0.11	35.7	41	7.8	LS	No	5.8	21.2	0
701-2A	12/ 2/76	0.08	36.3	41	8.6	LS	No	5.8	21.8	0
701-2A	12/ 3/76	0.11	35.4	39	7.9	LS	No	5.8	10.5	0
701-2A	12/ 4/76	0.23	41.7	58	8.4	LS	No	5.8	1.4	0
701-2A	12/ 5/76	0.42	45.6	74	7.8	LS	No	5.8	4.9	0
701-2A	12/ 6/76	0.09	33.7	39	7.6	LS	No	5.8	10.1	0
702-2A	12/ 7/76	0.07	55.2	43	15.7	LS	No	5.85	6.8	0
702-2A	12/ 8/76	0.20	52.7	51	15.5	LS	No	5.85	1.9	0
702-2A	12/ 9/76	0.09	55.4	50	15.1	LS	No	5.85	0.5	0
702-2A	12/10/76	0.10	47.1	50	15.5	LS	No	5.85	3.7	0
702-2A	12/11/76	0.10	52.1	49	15.3	LS	No	5.85	9.1	0
702-2A	12/12/76	0.41	62.4	58	15.4	LS	No	5.85	9.6	0
702-2A	12/13/76	0.37	66.5	56	15.1	LS	No	5.85	2.9	0
703-2A	12/14/76	0.83	54.3	59	7.9	LS	No	5.65	6.6	0
703-2A	12/15/76	0.47	45.3	53	7.6	LS	No	5.65	3.8	0
703-2A	12/17/76	0.15	40.5	46	8.0	LS	No	5.65	16.6	0
703-2A	12/17/76	0.19	45.4	54	7.9	LS	No	5.65	11.5	0
703-2A	12/18/76	0.40	45.8	57	7.7	LS	No	5.65	7.4	0
703-2A	12/19/76	0.73	52.8	53	7.6	LS	No	5.65	1.8	0
703-2A	12/20/76	0.47	54.4	47	7.7	LS	No	5.65	1.4	0
704-2A	12/23/76	0.22	41.7	51	8.2	LS	No	5.7	1.6	0
704-2A	12/24/76	0.17	42.2	49	8.6	LS	No	5.7	14.9	0
704-2A	12/25/76	0.05	42.5	43	8.4	LS	No	5.7	9.6	0
704-2A	12/26/76	0.05	39.8	42	8.9	LS	No	5.7	12.4	0
704-2A	12/27/76	0.06	37.9	47	8.0	LS	No	5.7	21.6	0
704-2A	12/28/76	0.06	36.3	42	8.0	LS	No	5.7	11.6	0
704-2A	12/29/76	0.06	38.9	42	8.2	LS	No	5.7	18.4	0
704-2A	12/30/76	0.19	45.8	58	8.1	LS	No	5.7	11.9	0
704-2A	12/31/76	0.17	42.8	47	8.0	LS	No	5.7	9.7	0
704-2A	1/ 1/77	0.15	41.8	56	8.2	LS	No	5.7	17.2	0
704-2A	1/ 2/77	0.19	41.5	50	7.9	LS	No	5.7	8.5	0
704-2A	1/ 3/77	0.34	43.8	59	7.9	LS	No	5.7	6.0	0
704-2A	1/ 4/77	0.10	40.7	46	8.0	LS	No	5.7	8.8	0
705-2A	1/ 5/77	0.10	51.9	57	14.8	LS	No	5.85	10.0	0
705-2A	1/ 7/77	0.10	47.2	54	14.7	LS	No	5.85	11.5	0
705-2A	1/11/77	0.09	52.3	53	16.0	LS	No	5.85	13.1	0
705-2A	1/12/77	0.09	53.0	54	15.0	LS	No	5.85	5.4	0
705-2A	1/13/77	0.08	50.4	54	15.1	LS	No	5.85	33.6	0
705-2A	1/14/77	0.08	45.9	53	15.0	LS	No	5.85	17.2	0

Table L-8 (continued)

SETTLING AND FUNNEL TEST RESULTS FOR THE VENTURI/SPRAY TOWER

Run No.	Date	Initial Settling Rate, cm/min	Ultimate Settled Solids, wt.%	Funnel Test Cake Solids, wt.%	Initial Solids, wt.%	Alkali	Fly Ash Loading	Venturi Inlet pH	Sample Oxidation, mole %	Air Stoich., $\frac{\text{lb-atoms O}}{\text{lb-mole SO}_2\text{ abs.}}$	Average Effective Magnesium, ppm
823-1A	5/13/78	0.77	64.9	-	7.6	LS	HIGH	6.8	95.7	1.68	5000
	5/14/78	0.37	72.8	-	10.3	LS	HIGH	6.0	98.0	1.87	5000
	5/15/78	0.29	77.1	-	13.2	LS	HIGH	5.5	95.9	2.16	5000
	5/16/78	0.37	59.8	-	17.9	LS	HIGH	6.5	98.5	1.62	5000
	5/17/78	0.29	65.2	75.7	17.1	LS	HIGH	6.3	96.9	1.54	5000
	5/20/78	0.46	60.8	73.6	15.6	LS	HIGH	6.2	98.1	1.58	5000
	5/21/78	0.46	39.9	72.1	6.3	LS	HIGH	6.3	91.8	1.57	5000
	5/22/78	0.42	68.3	73.5	16.2	LS	HIGH	6.4	98.6	1.54	5000
	5/23/78	0.46	62.7	73.7	15.9	LS	HIGH	6.4	97.3	1.58	5000
824-1A	5/24/78	0.55	77.4	72.6	18.6	LS	HIGH	6.3	98.3	1.77	5000
	5/25/78	0.35	72.1	72.9	20.1	LS	HIGH	6.1	99.2	1.86	5000
	5/26/78	0.55	74.9	73.1	20.1	LS	HIGH	5.9	94.7	1.40	5000
	5/27/78	0.38	62.1	73.3	20.2	LS	HIGH	6.0	99.0	1.65	5000
	5/28/78	0.37	78.8	72.3	16.2	LS	HIGH	5.9	96.4	1.67	5000
	5/29/78	0.31	67.7	74.6	19.9	LS	HIGH	5.9	98.7	1.75	5000
	5/30/78	0.32	75.2	73.2	21.5	LS	HIGH	5.9	97.3	1.45	5000
825-1A	5/31/78	0.53	74.4	74.4	18.0	LS	HIGH	5.9	98.9	1.68	5000
	6/1/78	0.50	84.5	74.8	18.3	LS	HIGH	6.0	98.0	1.71	5000
	6/2/78	0.46	75.2	73.1	18.3	LS	HIGH	5.8	96.1	1.36	5000
	6/3/78	0.50	71.0	72.4	15.5	LS	HIGH	5.8	97.7	1.49	5000
	6/5/78	0.61	76.1	72.8	14.7	LS	HIGH	5.5	99.5	1.68	5000
	6/6/78	0.46	71.3	73.5	15.3	LS	HIGH	5.6	96.9	1.53	5000
	6/7/78	0.44	89.1	72.5	18.7	LS	HIGH	5.4	99.0	1.66	5000
	6/8/78	0.35	61.6	70.7	14.7	LS	HIGH	5.4	93.0	1.58	5000
826-1A	6/11/78	0.42	70.7	73.0	16.1	LS	HIGH	5.3	97.4	--	5000
	6/13/78	0.35	70.5	70.9	14.5	LS	HIGH	5.5	99.5	--	5000
	6/14/78	0.38	61.8	75.2	15.6	LS	HIGH	5.4	97.3	--	5000
	6/15/78	0.37	63.7	73.3	14.6	LS	HIGH	5.2	95.8	1.29	5000
	6/16/78	0.31	65.7	70.8	16.6	LS	HIGH	5.4	87.5	1.35	5000
	6/17/78	0.37	76.6	71.6	16.6	LS	HIGH	5.4	95.7	1.33	5000
	6/18/78	0.60	74.4	72.9	16.9	LS	HIGH	5.7	97.8	1.40	5000
	6/19/78	0.46	94.6	80.9	17.6	LS	HIGH	5.5	96.0	1.52	5000

Table L-9

SETTLING AND FUNNEL TEST RESULTS FOR THE TCA

Run No.	Date	Initial Settling Rate, cm/min	Ultimate Settled Solids, wt. %	Funnel Test Cake Solids, wt. %	Initial Solids, wt. %	Alkali	Fly Ash	TCA Inlet pH, avg.	Sample Oxidation, mole %	Avg. Air Stoich. $\frac{\text{lb-atoms O}}{\text{lb-mole SO}_2\text{ abs.}}$
701-2A	11/29/76	0.13	38.5	40	8.0	LS	No	5.8	6.8	0
701-2A	11/30/76	0.08	33.6	42	8.3	LS	No	5.8	28.9	0
701-2A	12/ 2/76	0.11	35.7	41	7.8	LS	No	5.8	21.2	0
701-2A	12/ 2/76	0.08	36.3	41	8.6	LS	No	5.8	21.8	0
701-2A	12/ 3/76	0.11	35.4	39	7.9	LS	No	5.8	10.5	0
701-2A	12/ 4/76	0.23	41.7	58	8.4	LS	No	5.8	1.4	0
701-2A	12/ 5/76	0.42	45.6	74	7.8	LS	No	5.8	4.9	0
701-2A	12/ 6/76	0.09	33.7	39	7.6	LS	No	5.8	10.1	0
702-2A	12/ 7/76	0.07	55.2	43	15.7	LS	No	5.85	6.8	0
702-2A	12/ 8/76	0.20	52.7	51	15.5	LS	No	5.85	1.9	0
702-2A	12/ 9/76	0.09	55.4	50	15.1	LS	No	5.85	0.5	0
702-2A	12/10/76	0.10	47.1	50	15.5	LS	No	5.85	3.7	0
702-2A	12/11/76	0.10	52.1	49	15.3	LS	No	5.85	9.1	0
702-2A	12/12/76	0.41	62.4	58	15.4	LS	No	5.85	9.6	0
702-2A	12/13/76	0.37	66.5	56	15.1	LS	No	5.85	2.9	0
703-2A	12/14/76	0.83	54.3	59	7.9	LS	No	5.65	6.6	0
703-2A	12/15/76	0.47	45.3	53	7.6	LS	No	5.65	3.8	0
703-2A	12/17/76	0.15	40.5	46	8.0	LS	No	5.65	16.6	0
703-2A	12/17/76	0.19	45.4	54	7.9	LS	No	5.65	11.5	0
703-2A	12/18/76	0.40	45.8	57	7.7	LS	No	5.65	7.4	0
703-2A	12/19/76	0.73	52.8	53	7.6	LS	No	5.65	1.8	0
703-2A	12/20/76	0.47	54.4	47	7.7	LS	No	5.65	1.4	0
704-2A	12/23/76	0.22	41.7	51	8.2	LS	No	5.7	1.6	0
704-2A	12/24/76	0.17	42.2	49	8.6	LS	No	5.7	14.9	0
704-2A	12/25/76	0.05	42.5	43	8.4	LS	No	5.7	9.6	0
704-2A	12/26/76	0.05	39.8	42	8.9	LS	No	5.7	12.4	0
704-2A	12/27/76	0.06	37.9	47	8.0	LS	No	5.7	21.6	0
704-2A	12/28/76	0.06	36.3	42	8.0	LS	No	5.7	11.6	0
704-2A	12/29/76	0.06	38.9	42	8.2	LS	No	5.7	18.4	0
704-2A	12/30/76	0.19	45.8	58	8.1	LS	No	5.7	11.9	0
704-2A	12/31/76	0.17	42.8	47	8.0	LS	No	5.7	9.7	0
704-2A	1/ 1/77	0.15	41.8	56	8.2	LS	No	5.7	17.2	0
704-2A	1/ 2/77	0.19	41.5	50	7.9	LS	No	5.7	8.5	0
704-2A	1/ 3/77	0.34	43.8	59	7.9	LS	No	5.7	6.0	0
704-2A	1/ 4/77	0.10	40.7	46	8.0	LS	No	5.7	8.8	0
705-2A	1/ 5/77	0.10	51.9	57	14.8	LS	No	5.85	10.0	0
705-2A	1/ 7/77	0.10	47.2	54	14.7	LS	No	5.85	11.5	0
705-2A	1/11/77	0.09	52.3	53	16.0	LS	No	5.85	13.1	0
705-2A	1/12/77	0.09	53.0	54	15.0	LS	No	5.85	5.4	0
705-2A	1/13/77	0.08	50.[illegible]	54	15.1	LS	No	5.85	33.6	0
705-2A	1/14/77	0.08	45.9	53	15.0	LS	No	5.85	17.2	0

Table L-9 (continued)

SETTLING AND FUNNEL TEST RESULTS FOR THE TCA

Run No.	Date	Initial Settling Rate, cm/min	Ultimate Solids Solids, wt. %	Funnel Test Cake Solids, wt. %	Initial Solids, wt. %	Alkali	Fly Ash	TCA Inlet pH, avg.	Sample Oxidation, mole %	Avg. Air Stoich. $\frac{\text{lb-atoms O}}{\text{lb-mole } SO_2 \text{ abs.}}$	Average Eff. Mag., ppm
706-2A	1/22/77	0.06	50.4	50	14.7	LS	No	5.55	10.4	0	0
706-2A	2/ 3/77	0.09	46.3	49	13.8	LS	No	5.55	10.9	0	0
713-2A	6/20/77	0.08	46.7	49	14.5	LS	Yes	5.7	19.2	0	0
801-2B	6/29/77	0.30	66.9	68	14.5	LS	Yes	5.8	58.6	5.6	0
801-2B	6/30/77	0.50	69.1	73	16.0	LS	Yes	5.8	65.5	5.6	0
802-2A	7/ 7/77	0.09	59.6	65	14.8	LS	Yes	5.75	49.3	4.5	0
803-2A	7/ 9/77	0.92	64.9	77	14.1	LS	Yes	5.05	87.9	5.2	0
804-2A	7/16/77	1.05	84.4	76	14.8	LS	Yes	5.00	93.3	4.5	0
804-2A	7/18/77	1.18	72.7	75	16.5	LS	Yes	5.00	84.4	4.5	0
804-2A	7/20/77	0.99	76.1	80	15.0	LS	Yes	5.00	94.5	4.5	0
804-2A	7/22/77	1.22	73.3	80	13.8	LS	Yes	5.00	91.0	4.5	0
805-2A	7/25/77	0.80	71.1	80	13.9	LS	Yes	5.35	95.7	4.4	0
805-2A	7/27/77	1.08	67.2	74	14.2	LS	Yes	5.35	98.2	4.4	0
805-2A	7/28/77	1.26	77.5	73	14.8	LS	Yes	5.35	97.6	4.4	0
806-2A	7/29/77	0.63	73.7	73	16.1	LS	Yes	5.35	93.8	2.8	0
806-2A	7/30/77	0.05	53.4	62	14.7	LS	Yes	5.35	42.0	2.8	0
806-2A	7/31/77	0.13	50.0	63	14.5	LS	Yes	5.35	54.1	2.8	0
806-2A	8/ 1/77	0.18	65.7	67	15.0	LS	Yes	5.35	65.3	2.8	0
806-2A	8/ 2/77	0.36	57.1	70	14.3	LS	Yes	5.35	56.4	2.8	0
807-2A	8/ 3/77	1.22	75.3	79	16.7	LS	Yes	5.45	90.3	4.3	0
807-2A	8/ 4/77	1.02	70.2	78	15.9	LS	Yes	5.45	76.5	4.3	0
807-2A	8/ 5/77	0.96	72.0	75	15.0	LS	Yes	5.45	98.1	4.3	0
807-2A	8/ 6/77	0.96	66.1	77	14.5	LS	Yes	5.45	96.4	4.3	0
807-2A	8/ 7/77	1.31	68.3	81	13.8	LS	Yes	5.45	93.2	4.3	0
807-2A	8/ 8/77	1.02	71.4	79	14.8	LS	Yes	5.45	97.8	4.3	0
807-2A	8/ 9/77	1.02	73.9	79	15.1	LS	Yes	5.45	98.5	4.3	0
807-2A	8/10/77	1.02	69.0	73	15.0	LS	Yes	5.45	97.4	4.3	0
808-2A	8/11/77	0.94	76.8	75	15.5	LS	Yes	5.1	89.8	2.0	0
808-2A	8/12/77	0.89	75.3	73	15.9	LS	Yes	5.1	98.7	2.0	0
808-2A	8/13/77	0.73	70.2	74	14.4	LS	Yes	5.1	83.7	2.0	0
808-2A	8/14/77	0.87	71.1	73	14.5	LS	Yes	5.1	96.0	2.0	0
808-2A	8/15/77	0.94	80.0	75	15.5	LS	Yes	5 1	86.6	2.0	0
808-2A	8/16/77	0.81	76.3	76	15.1	LS	Yes	5.1	94.9	2.0	0

Table L-9 (continued)

SETTLING AND FUNNEL TEST RESULTS FOR THE TCA

Run Number	Date	Initial Settling Rate, cm/min	Ultimate Settled Solids, wt%	Funnel Test Cake Solids, wt%	Initial Solids, wt%	Alkali	Fly Ash	TCA Inlet pH	Sample Oxidation, mole %	Avg. Air Stoich. $\frac{\text{lb-atoms O}}{\text{lb-moles SO}_2\text{ abs.}}$
809-2A	8/18/77	1.18	80.1	78.0	16.4	LS	Yes	5.4	93.6	3.24
	8/20/77	0.96	79.2	75.6	17.2	LS	Yes	5.3	93.0	2.54
	8/22/77	0.81	78.1	75.2	16.2	LS	Yes	5.0	97.7	2.31
	8/23/77	0.96	75.1	73.1	14.7	LS	Yes	5.8	90.4	2.95
810-2A	8/26/77	1.02	74.0	74.6	14.8	LS	Yes	5.6	98.6	2.57
	8/28/77	1.02	80.5	80.8	14.9	LS	Yes	4.8	99.1	2.45
	8/29/77	0.92	75.0	87.9	14.9	LS	Yes	5.7	99.5	2.57
	8/29/77	1.02	74.7	75.9	14.8	LS	Yes	--	96.1	2.50
714-2A	9/1/77	0.11	47.5	62.9	16.2	LS	Yes	5.7	31.6	0
	9/2/77	0.09	41.5	79.6	16.1	LS	Yes	5.8	13.8	0
	9/3/77	0.13	49.6	53.7	15.1	LS	Yes	5.8	20.1	0
	9/6/77	0.21	58.0	--	14.6	LS	Yes	5.8	1.7	0
	9/6/77*	0.28 (5 ppm)	42.6	--	14.6	LS	Yes	--	--	0
	9/6/77*	0.37 (10 ppm)	49.1	--	14.6	LS	Yes	--	--	0
	9/6/77*	0.48 (15 ppm)	49.1	--	14.6	LS	Yes	--	--	0
	9/6/77	0.48 (25 ppm)	49.1	--	14.6	LS	Yes	--	--	0
	9/6/77	0.48 (10 ppm)	38.0	--	14.6	LS	Yes	--	--	0
	9/8/77	1.69	82.8	51.5	14.7	LS	Yes	6.1	4.7	0
	9/9/77	0.20	60.2	54.0	14.6	LS	Yes	6.0	6.1	0
811-2A	9/10/77	1.03	76.7	73.3	12.5	LS	Yes	5.8	82.4	2.77
	9/12/77	1.03	71.0	72.7	15.7	LS	Yes	6.0	92.2	2.19
	9/14/77	1.10	31.1	74.8	16.0	LS	Yes	5.8	92.2	2.24
812-2A	9/16/77	1.09	77.1	74.3	15.6	LS	Yes	5.7	94.7	2.87
	9/18/77	1.27	86.3	74.3	16.7	LS	Yes	5.6	92.3	3.22
	9/20/77	1.07	69.9	73.6	15.9	LS	Yes	5.7	94.2	3.07
	9/22/77	1.29	68.2	74.6	11.3	LS	Yes	5.7	96.6	3.08
813-2A	9/25/77	0.61	63.9	71.5	13.8	LS	Yes	5.2	85.5	3.48
	9/26/77	1.14	79.1	74.1	14.8	LS	Yes	5.3	90.9	2.72
	9/28/77	1.47	66.9	75.1	14.3	LS	Yes	5.2	97.0	3.54
814-2A	9/30/77	0.06	59.6	56.1	14.4	LS	Yes	5.3	72.4	1.32
	10/2/77	0.42	53.3	60.1	14.0	LS	Yes	5.4	53.2	1.61
	10/3/77	0.35	61.0	61.7	14.5	LS	Yes	5.7	70.7	1.27
715-2A	10/8/77	0.07	37.1	47.1	14.3	LS	Yes	5.6	24.7	0
	10/11/77	0.12	49.4	50.0	15.0	LS	Yes	5.7	21.1	0
	10/13/77	0.10	44.6	50.9	15.2	LS	Yes	5.6	28.1	0

* Slurry with American Cynamid's anionic flocculant, Superfloc 1204, added in concentrations indicated

Table L-9 (continued)

SETTLING AND FUNNEL TEST RESULTS FOR THE TCA

Run Number	Date	Initial Settling Rate, cm/min	Ultimate Settled Solids, wt%	Funnel Test Cake Solids, wt%	Initial Solids, wt%	Alkali	Fly Ash	TCA Inlet pH	Sample Oxidation, mole %	Avg. Air Stoich. $\frac{\text{lb-atoms O}}{\text{lb-moles SO}_2\text{ abs.}}$
716-2A	10/15/77	0.10	50.6	53.5	14.6	LS	Yes	5.8	16.0	0
	10/17/77	0.14	47.8	52.0	13.1	LS	Yes	5.7	33.1	0
	10/19/77	0.09	53.4	53.1	15.0	LS	Yes	5.8	25.4	0
717-2A	10/21/77	0.16	51.9	54.2	15.4	LS	Yes	5.7	36.3	0
	10/23/77	0.16	61.9	51.1	14.8	LS	Yes	6.0	17.4	0
	10/25/77	0.37	63.4	48.6	14.9	LS	Yes	5.9	13.9	0
	10/28/77	0.31	56.4	65.4	14.4	LS	Yes	5.9	15.0	0
	10/31/77	0.15	55.5	84.0	14.8	LS	Yes	5.8	34.9	0
	11/2/77	0.13	48.1	79.9	14.9	LS	Yes	5.7	11.6	0
	11/4/77	0.31	62.3	91.4	14.1	LS	Yes	5.8	20.0	0
	11/6/77	0.17	50.9	72.2	14.1	LS	Yes	5.9	16.4	0
	11/8/77	0.18	66.9	55.7	15.4	LS	Yes	6.1	17.8	0
	11/10/77	0.12	49.0	52.5	15.7	LS	Yes	6.0	11.5	0
	11/12/77	0.48	85.1	54.5	14.3	LS	Yes	6.0	14.4	0
	11/14/77	0.26	68.4	51.9	14.8	LS	Yes	5.9	14.4	0
	11/16/77	0.11	49.6	52.5	14.8	LS	Yes	5.8	28.4	0
	11/18/77	0.11	47.1	58.4	14.4	LS	Yes	6.0	16.9	0
	11/20/77	0.12	55.0	48.9	15.3	LS	Yes	6.0	17.8	0
	11/25/77	0.13	43.9	52.2	15.1	LS	Yes	5.6	28.8	0
	11/26/77	0.35	92.5	53.0	13.6	LS	Yes	5.6	27.4	0
	11/27/77	0.13	50.7	51.5	13.1	LS	Yes	5.9	16.7	0
	11/29/77	0.18	55.2	55.7	14.7	LS	Yes	5.9	27.2	0
719-2A	12/3/77	0.29	55.5	47.5	13.9	LS	Yes	5.5	19.2	0
	12/4/77	0.28	56.7	56.4	14.0	LS	Yes	5.6	21.8	0
	12/8/77	0.14	49.1	57.1	14.6	LS	Yes	5.9	13.4	0
	12/9/77	0.15	55.3	56.3	14.7	LS	Yes	5.8	24.6	0
	12/12/77	0.18	56.2	57.9	15.4	LS	Yes	6.2	36.3	0
816-2A	12/15/77	0.17	55.4	60.2	16.1	LS	Yes	6.4	37.6	1.03
	12/16/77	0.35	72.0	63.2	16.2	LS	Yes	6.3	50.5	0.99
817-2A	12/18/77	0.85	38.8	78.5	14.1	LS	Yes	6.0	85.6	1.78
	12/20/77	0.92	87.0	76.9	16.4	LS	Yes	5.8	82.1	1.71
	12/23/77	1.47	79.9	79.5	14.7	LS	Yes	5.8	98.6	1.76
818-2A	12/27/77	0.11	51.5	63.4	14.3	LS	Yes	6.2	59.1	1.28
	12/28/77	0.42	67.2	57.2	14.2	LS	Yes	6.2	56.7	1.21
	12/30/77	0.40	61.0	61.5	14.9	LS	Yes	6.4	63.9	1.24

Table L-9 (continued)

SETTLING AND FUNNEL TEST RESULTS FOR THE TCA

Run Number	Date	Initial Settling Rate, cm/min	Ultimate Settled Solids, wt%	Funnel Test Cake Solids, wt%	Initial Solids, wt%	Alkali	Fly Ash	TCA Inlet pH	Sample Oxidation, mole %	Avg. Air. Stoich. $\frac{\text{lb-atoms O}}{\text{lb-moles SO}_2\text{ abs.}}$
818-2B	1/01/78	0.25	57.2	49.5	14.7	LS	Yes	6.1	19.6	--
	1/03/78	0.31	55.9	63.5	15.3	LS	Yes	6.2	15.8	--
	1/05/78	0.15	51.2	51.4	14.5	LS	Yes	5.5	27.2	--
819-2A	1/07/78	1.03	59.0	73.1	14.2	LS	Yes	5.4	92.9	1.81
	1/09/78	1.38	61.7	72.4	13.5	LS	Yes	5.7	98.5	1.85
	1/12/78	1.23	69.3	70.5	14.3	LS	Yes	5.6	92.4	1.82
	1/13/78	1.47	58.8	73.6	12.2	LS	Yes	5.5	93.3	2.06

Table L-9 (continued)

SETTLING AND FUNNEL TEST RESULTS FOR THE TCA

Run No.	Date	Initial Settling Rate, cm/min	Ultimate Settled Solids, wt.%	Funnel Test Cake Solids, wt.%	Initial Solids, wt.%	Alkali	Fly Ash Loading	TCA Inlet pH	Sample Oxidation, mole %	Air Stoich., $\frac{\text{lb-atoms O}}{\text{lb-mole SO}_2\text{ abs.}}$	Average Effective Magnesium, ppm
820-2A	1/16/78	1.15	64.2	73.8	13.0	LS	HIGH	5.6	87.9	1.93	-
	1/18/78	0.92	68.1	76.3	14.5	LS	HIGH	5.4	84.6	1.99	-
	1/20/78	1.10	65.5	74.8	14.3	LS	HIGH	5.7	90.4	1.95	-
	1/22/78	1.29	70.8	73.0	12.0	LS	HIGH	5.9	91.7	2.52	-
	1/24/78	1.23	62.5	72.2	12.5	LS	HIGH	5.8	94.3	2.08	-
590-2B	2/3/78	0.12	49.6	--	15.4	LS	HIGH	5.1	32.6	--	-
	2/4/78	0.18	50.3	--	14.2	LS	HIGH	5.4	24.9	--	-
618-2B	2/13/78	1.65	57.8	61.4	8.0	L	HIGH	6.9	39.7	--	-
	2/15/78	1.42	48.9	61.1	7.9	L	HIGH	7.1	34.2	--	-
619-2A	2/21/78	0.22	43.2	47.6	8.3	L	HIGH	6.9	22.3	--	2000
	2/22/78	0.40	32.5	47.1	8.8	L	HIGH	5.2	22.9	--	2000
	2/24/78	0.74	41.1	63.3	7.3	L	HIGH	7.0	8.5	--	2000
	2/25/78	0.96	49.4	68.2	7.7	L	HIGH	7.3	32.8	--	2000
	2/26/78	1.00	35.0	83.8	7.2	L	HIGH	6.4	42.7	--	2000
	2/28/78	0.67	33.5	42.7	7.4	L	HIGH	7.0	39.1	--	2000
	3/1/78	0.84	37.9	54.5	7.5	L	HIGH	6.9	24.4	--	2000
	3/2/78	0.77	48.4	50.4	7.8	L	HIGH	6.8	17.8	--	2000
620-2A	3/4/78	0.50	31.1	52.9	7.3	L	HIGH	7.3	26.7	--	2000
	3/6/78	1.15	42.3	52.0	9.1	L	HIGH	8.2	37.0	--	2000
621-2A	3/18/78	0.85	57.1	50.9	9.8	L	HIGH	6.7	42.6	--	2000
	3/21/78	0.61	38.8	44.7	6.8	L	HIGH	6.7	34.9	--	2000
	3/23/78	1.36	50.4	51.8	8.9	L	HIGH	7.4	37.4	--	2000
	3/24/78	0.82	40.3	53.2	8.8	L	HIGH	6.8	24.9	--	2000
	3/25/78	0.92	51.7	54.9	8.2	L	HIGH	7.0	25.4	--	2000
591-2A	3/28/78	0.41	52.6	64.1	10.1	LS	HIGH	4.8	70.2	--	5000
	3/29/78	0.37	60.5	60.5	15.1	LS	HIGH	4.6	72.3	--	5000
	3/30/78	0.06	29.8	45.0	12.1	LS	HIGH	5.4	41.1	--	5000
	4/3/78	0.07	36.9	54.2	13.7	LS	HIGH	5.5	41.0	--	5000
	4/4/78	0.08	46.0	59.3	14.6	LS	HIGH	5.5	49.8	--	5000
592-2A	4/6/78	0.07	34.5	78.0	13.2	LS	HIGH	5.5	21.4	--	9000
	4/10/78	0.14	46.0	68.5	14.5	LS	HIGH	5.0	48.8	--	9000
	4/11/78	0.05	37.1	55.3	14.2	LS	HIGH	5.5	36.3	--	9000
	4/12/78	0.06	52.7	53.2	15.4	LS	HIGH	5.5	35.1	--	9000
	4/17/78	0.05	44.1	47.8	14.5	LS	HIGH	5.4	10.0	--	9000
	4/18/78	0.04	42.6	49.2	15.1	LS	HIGH	5.5	18.6	--	9000
	4/19/78	0.04	44.2	47.1	17.0	LS	HIGH	5.3	35.5	--	9000
	4/21/78	0.04	45.9	60.8	15.0	LS	HIGH	5.5	24.8	--	9000
593-2A	4/24/78	0.04	29.7	53.4	14.2	LS	HIGH	5.4	38.3	--	9000
	4/25/78	0.04	41.4	51.8	14.0	LS	HIGH	5.3	37.5	--	9000
	4/28/78	--	--	46.8	14.7	LS	HIGH	5.4	29.1	--	9000
	5/1/78	0.04	42.5	52.0	15.5	LS	HIGH	5.5	13.9	--	9000
	5/2/78	0.04	32.3	49.0	15.6	LS	HIGH	5.5	19.3	--	9000
594-2A	5/5/78	0.01	32.1	56.7	14.5	LS	HIGH	5.2	20.9	--	9000
	5/6/78	0.11	45.4	54.1	14.8	LS	HIGH	5.2	11.0	--	9000
622-2A	5/10/78	0.71	32.9	37.7	8.0	L	HIGH	7.1	17.8	--	9000
	5/11/78	0.74	59.3	--	7.9	L	HIGH	7.0	22.7	--	9000
	5/12/78	0.75	45.0	--	8.2	L	HIGH	7.2	28.8	--	9000

Table L-10

FILTER LEAF TEST RESULTS FOR TEST BLOCKS 2, 3, AND 8

Test Block	Form Time, sec	Dry Time, sec	Cycle Time, sec	Initial Solids, wt. %	Cake Solids, wt. %	Cake Thickness, in.	Dry Solids Loading, lb/ft^2-hr	Filtrate Loading, gal/ft^2-hr	Submergence, % of cycle	Comments
2	10	20	40	58.3	80.1	1	663	41.6	25.0	Run 853-1A (3/21/76). Sample was 95 percent oxidized. Lime, fly ash, 2 stage forced oxidation.
2	5	25	40	58.4	82.3	3/4	428	27.3	12.5	
2	5	40	60	59.5	83.1	3/4	320	19.7	8.3	
2	5	60	87	57.4	85.6	11/16	171	12.6	5.7	
2	10	20	40	60.7	78.6	1	640	30.9	25.0	
3	5	25	40	--	70.1	1/4	236	--	12.5	Run 853-1A (3/18/76). Sample from early in test during air problems. Oxidation was ~36 percent.
3	5	40	60	52.9	70.0	1/4	155	9.2	8.3	
3	5	60	87	--	--	1/4	--	6.8	5.7	
3	10	20	40	53.4	70.2	3/8	135	16.9	25.0	
3	5	60	87	52.0	69.5	1/4	229	6.6	5.7	
3	5	40(1)	60	53.9	74.0	1/4	157	10.1	8.3	
3	5	40(1)	60	53.9	73.7	1/4	151	9.7	8.3	
8	5	25	40	60.0	82.1	7/16	248	14.3	12.5	Run 808-1A (3/8/77). Sample was 99 percent oxidized. Limestone, fly ash, 2 stage forced oxidation.
8	5	40	60	58.4	82.0	7/16	168	10.6	8.3	
8	5	60	87	58.9	82.0	7/16	116	7.1	5.7	
8	10	20	40	60.8	79.4	5/8	362	17.8	25.0	
8	5	25	40	58.9	79.8	7/16	258	14.7	12.5	

9/16/77

(1) 20 seconds with flapper and 20 seconds without flapper.

Table L-11

FILTER LEAF TEST RESULTS FOR TEST BLOCK 5

Form Time, sec	Dry Time, sec	Cycle Time, (1) sec	Initial Solids, wt. %	Cake Solids, wt. %	Cake Thickness, in.	Dry Solids Loading, lb/ft^2-hr	Filtrate Loading, gal/ft^2-hr	Submergence, % of cycle
5	20	33.3	46.4	71.3	7/16 - 9/16	339.9	30.6	30
5	20	33.3	47.9	70.1	3/8	294.6	23.3	30
5	20	33.3	54.4	79.2	5/16 - 7/16	309.3	21.3	30
5	30	46.7	49.0	73.2	3/8 - 1/2	191.7	15.5	21
5	30	46.7	48.1	71.3	3/8 - 1/2	182.4	14.8	21
5	30	46.7	52.9	76.8	3/8 - 1/2	240.7	17.0	21
5	40	60.0	57.0	85.3	3/8 - 1/2	169.7	11.8	17
5	40	60.0	55.0	82.6	3/8 - 1/2	164.1	11.9	17
5	40	60.0	57.0	83.8	7/16 - 9/16	169.7	11.4	17
5	60	86.7	57.0	85.8	5/16 - 7/16	117.9	8.3	12
5	60	86.7	52.8	79.5	5/16 - 1/2	103.5	7.9	12
5	60	86.7	58.9	88.8	5/16 - 1/2	128.8	8.8	12
5	20	33.3	59.2	83.8	7/16 - 1/2	359.8	22.5	30

8/17/77

(1) Assumes start of form time at 6 o'clock position, discharge at 3 o'clock position (scraper discharge).

(2) Run 860-1A (8/9/77, 0900), Sample was 97.8 percent oxidized. Lime, fly ash-free, forced oxidation run.

Table L-12

FILTER LEAF TEST RESULTS FOR TEST BLOCK 6

Form Time, sec	Dry Time, sec	Cycle Time,[1] sec	Initial Solids, wt. %	Cake Solids, wt. %	Cake Thickness, in.	Dry Solids Loading, lb/ft^2-hr	Filtrate Loading, gal/ft^2-hr	Submergence, % of cycle
5	20	33.3	40.3	51.5	7/16	288.4	18.8	30
5	20	33.3	39.3	49.9	3/8	281.0	18.1	30
5	20	33.3	39.5	49.7	3/8 - 1/2	304.6	18.9	30
5	30	46.7	39.1	52.0	3/8 - 1/2	209.9	16.0	21
5	30	46.7	38.8	49.7	3/8 - 7/16	219.1	14.8	21
5	30	46.7	39.4	49.9	3/8 - 7/16	215.9	14.2	21
5	40	60.0	39.9	50.7	7/16	156.5	10.0	17
5	40	60.0	40.9	53.1	7/16	156.4	10.5	17
5	40	60.0	39.5	50.2	7/16 - 1/2	162.1	10.5	17
5	60	86.7	39.4	50.4	7/16	107.3	7.1	12
5	60	86.7	40.1	50.2	7/16	122.4	7.4	12
5	60	86.7	38.8	50.2	7/16	105.5	7.4	12
5	20	33.3	39.3	49.9	7/16	280.5	18.1	30

8/17/77

(1) Assumes start of form time at 6 o'clock position, discharge at 3 o'clock position (scraper discharge).

(2) Run 857-1A (7/12/77, 1300). Sample was 24.1 percent oxidized. Lime, fly ash-free, no forced oxidation. Sample taken from spray tower slurry loop.

Table L-13

FILTER LEAF TEST RESULTS FOR TEST BLOCK 7

Form Time, sec	Dry Time, sec	Cycle Time,(1) sec	Initial Solids, wt. %	Cake Solids, wt. %	Cake Thickness, in.	Dry Solids Loading, lb/ft^2-hr	Filtrate Loading, gal/ft^2-hr	Submergence, % of cycle
5	20	33.3	59.1	86.7	1/4 - 3/8	338.6	21.9	30
5	20	33.3	51.1	78.7	1/4 - 5/16	250.3	20.6	30
5	20	33.3	51.9	78.9	5/16 - 7/16	314.8	24.9	30
5	30	46.7	53.1	80.1	5/16 - 3/8	234.1	17.8	21
5	30	46.7	52.7	78.8	5/16 - 7/16	211.9	16.0	21
5	30	46.7	53.5	80.7	5/16 - 7/16	243.8	18.4	21
5	40	60.0	53.0	80.0	5/16 - 7/16	175.4	13.4	17
5	40	60.0	51.8	79.5	5/16 - 3/8	164.3	13.3	17
5	40	60.0	52.9	80.2	5/16 - 7/16	208.5	16.1	17
5	60	86.7	52.2	77.8	5/16 - 7/16	117.3	8.8	12
5	60	86.7	52.2	79.2	3/8 - 1/2	134.8	10.5	12
5	60	86.7	54.3	80.1	5/16 - 3/8	143.3	10.2	12
5	20	33.3	52.6	76.4	5/16 - 7/16	334.6	23.8	30

8/17/77

(1) Assumes start of form time at 6 o'clock position, discharge at 3 o'clock position (scraper discharge).

(2) Run 804-2A (7/22/77, 1200). Sample was 99.3 percent oxidized. Limestone, fly ash, 1 stage forced oxidation.

Table L-14

OPERATING VARIABLES DURING PARTICLE SIZE DISTRIBUTION TESTING WITH THE HYDROCLONE

Inlet Pressure, psig	Feed		Overflow		Underflow	
	Flow Rate, gpm[1]	Solids, wt%	Flow Rate, gpm[2]	Solids, wt%	Flow Rate, gpm[2,4]	Solids, wt%
27.0	18.4	13.8	15.5	2.0	3.3	52.7
27.2	18.4	14.0	15.5	1.98	3.2	52.13
27.4	18.4	13.89	15.5	1.93	3.3	55.14
27.5[3]	18.4	15.37	15.3	1.87	3.3	59.08
17.5	15.0	14.61	12.1	2.18	2.0	54.37
17.2	15.0	14.41	12.0	2.25	1.9	67.88
17.0	15.0	14.36	12.0	2.19	1.9	68.21
17.0[3]	15.0	14.25	11.9	3.27	1.9	32.69
13	12.8	15.52	10.3	2.59	2.7	53.19
12.8	12.8	15.14	9.8	2.75	2.8	54.06
12.1	12.8	14.27	10.1	2.83	2.5	69.55
12.0[3]	12.8	14.99	10.2	2.67	2.6	55.11

[1] Measured with a magnetic flow meter.

[2] Measured by bucket and stopwatch.

[3] Samples taken for Chemical Analyses and Particle Size Distribution.

[4] Values at 15.0 gpm feed rate are questionable. Error may be due to incorrect reading of stopwatch.

Table L-15

RESULTS OF TWO-HOUR HYDROCLONE TEST:
SOLIDS ANALYSES AT 18 GPM FEED RATE

	Feed	Overflow	Underflow	Percent in Overflow[1]
Pressure, psig	27.5			
Flow Rate, gpm	18.4	15.3	3.3	82
Solids, wt%	15.37	1.86	59.08	
Fly Ash, wt% in solids[2]	28.4	66.7	21.3	26
$CaSO_3$, wt% in solids[3]	1.8	1.9	1.2	15
$CaSO_4$, wt% in solids[4]	45.6	10.8	56.5	2.1
$CaCO_3$, wt% in solids[5]	5.1	4.3	5.1	9

[1] From Mass Balances Based on Total Solids in Samples = 100% and Percent Overhead = 100 x Overflow/(Overflow + Underflow)

[2] Measured as Acid Insolubles

[3] Based on Measured Sulfite

[4] Based on Measured Sulfite and Total Sulfur

[5] Based on Measured Carbonate

Table L-16

RESULTS OF TWO-HOUR HYDROCLONE TEST: SOLIDS ANALYSES AT 15 GPM FEED RATE

	Feed	Overflow	Underflow	Percent in Overflow[1]
Pressure, psig	17.0			
Flow Rate, gpm	15.0	11.9	1.9	86
Solids, wt%	14.24	3.26	32.69	
Fly Ash, wt% in solids[2]	34.7	70.6	17.9	38
$CaSO_3$, wt% in solids[3]	1.3	2.5	1.9	17
$CaSO_4$, wt% in solids[4]	47.8	11.3	58.0	2.9
$CaCO_3$, wt% in solids[5]	4.8	4.3	4.7	13

[1] From Mass Balances Based on Total Solids in Samples = 100% and Percent Overhead = 100 x Overflow/(Overflow + Underflow)

[2] Measured as Acid Insolubles

[3] Based on Measured Sulfite

[4] Based on Measured Sulfite and Total Sulfur

[5] Based on Measured Carbonate

Table L-17

RESULTS OF TWO-HOUR HYDROCLONE TEST: SOLIDS ANALYSES AT 12 GPM FEED RATE

	Feed	Overflow	Underflow	Percent in Overflow[1]
Pressure, psig	12.0			
Flow Rate, gpm	12.8	10.2	2.6	79
Solids, wt%	14.98	2.67	55.10	
Fly Ash, wt% in solids[2]	29.5	59.2	31.5	22
$CaSO_3$, wt% in solids[3]	2.3	6.1	1.5	37
$CaSO_4$, wt% in solids[4]	46.8	13.1	56.0	3.3
$CaCO_3$, wt% in solids[5]	5.9	7.1	6.4	14

[1] From Mass Balances Based on Total Solids in Samples = 100% and Percent Overhead = 100 x Overflow/(Overflow + Underflow)

[2] Measured as Acid Insolubles

[3] Based on Measured Sulfite

[4] Based on Measured Sulfite and Total Sulfur

[5] Based on Measured Carbonate

APPENDIX M

PARTICULATE MASS LOADING TEST RESULTS

This Appendix presents the results of routine mass loading tests performed on the venturi/spray tower and TCA systems during the reporting period.

Table M-1

VENTURI/SPRAY TOWER PARTICULATE MASS LOADING TEST RESULTS

Run No.	Date	Inlet, gr/dscf	Outlet, gr/dscf	Removal, %	Alkali	Fly Ash	System ΔP,(1) in. H_2O	Venturi ΔP, in. H_2O	Gas Rate, acfm @ 300°F	Slurry Rate, gpm	
										V	ST
806-1C	2/28/77	5.08	0.023	99.5	LS	Yes	11.5	9.0	25,000	400	1400
807-1A	3/ 4/77	4.52	0.023	99.5	LS	Yes	10.7	9.0	25,000	600	1400
808-1A	3/ 7/77	5.33	0.025	99.5	LS	Yes	10.8	9.0	25,000	600	1400
808-1A	3/ 7/77	4.06	0.022	99.5	LS	Yes	10.8	9.0	25,000	600	1400
808-1A	3/ 8/77	6.05	0.039	99.4	LS	Yes	10.8	9.0	25,000	600	1400
808-1A	3/ 8/77	4.86	0.029	99.4	LS	Yes	10.8	9.0	25,000	600	1400
852-1A	3/17/77	5.48	0.039	99.3	L	Yes	3.4	2.3	25,000	160	1400
852-1A	3/17/77	4.14	0.041	99.0	L	Yes	3.4	2.3	25,000	160	1400
852-1A	3/18/77	5.25	0.052	99.0	L	Yes	3.3	2.0	25,000	160	1400
852-1A	3/18/77	4.59	0.062	98.6	L	Yes	3.3	2.0	25,000	160	1400
855-1A	6/22/77	--	0.005	--	L	No	11.7	9.0	25,000	600	1400
855-1A	6/23/77	--	0.006	--	L	No	11.8	9.0	25,000	600	1400
856-1A	6/29/77	--	0.007	--	L	No	11.8	9.0	25,000	600	1400
856-1A	7/ 5/77	--	0.005	--	L	No	11.7	9.0	25,000	600	1400
856-1A	7/ 8/77	--	0.005	--	L	No	11.9	9.0	25,000	600	1400
856-1A	7/11/77	--	0.010	--	L	No	11.7	9.0	25,000	600	1400
858-1A	7/14/77	--	0.007	--	L	No	11.5	9.0	25,000	600	1400
858-1A	7/15/77	--	0.012	--	L	No	11.5	9.0	25,000	600	1400
858-1A	7/18/77	--	0.007	--	L	No	11.6	9.0	25,000	600	1400
858-1A	7/19/77	--	0.007	--	L	No	11.5	9.0	25,000	600	1400
859-1C	8/ 2/77	--	0.009	--	L	No	11.9	9.0	25,000	600	1400
810-1A	8/23/77	--	0.006	--	LS	No	11.7	9.0	25,000	600	1400
811-1A	9/ 1/77	--	0.007	--	LS	No	11.5	9.0	25,000	600	1400
815-1A	9/19/77	--	0.013	--	LS	No	15.5	9.0	35,000	600	1400
815-1A	9/21/77	--	0.009	--	LS	No	15.4	9.0	35,000	600	1400
815-1A	9/22/77	--	0.019	--	LS	No	16.7	9.0	35,000	600	1400
815-1A	9/23/77	--	0.013	--	LS	No	16.8	9.0	35,000	600	1400

(1) Excluding mist eliminator pressure drop.

Table M-1 (continued)
VENTURI/SPRAY TOWER PARTICULATE MASS LOADING TEST RESULTS

Run No.	Date	Inlet, gr/dscf	Outlet, gr/dscf	Removal, %	Alkali	Fly Ash	System ΔP,(1) in. H_2O	Venturi ΔP, in. H_2O	Gas Rate, acfm @ 300°F	Slurry Rate, gpm	
										V	ST
819-1A	11/ 3/77	4.12	0.036	99.1	LS	Yes	15.0	9.1	33,000	600	1600
	11/ 4/77	4.53	0.021	99.5	↓	↓	13.1	8.2	31,000	↓	↓
	11/ 7/77	--	0.048	--	↓	↓	11.2	6.6	29,000	↓	↓
		--	0.035	--	↓	↓	11.3	6.8	29,000	↓	↓
	11/ 8/77	3.32	--	--	↓	↓	--	--	--	↓	↓
		--	0.030	--	↓	↓	6.0	3.6	19,500	↓	↓
	11/14/77	4.08	0.047	98.8	↓	↓	7.9	3.8	20,000	↓	↓
		3.93	0.041	99.0	↓	↓	--	3.5	20,000	↓	↓
	11/21/77	3.09	0.040	98.7	↓	↓	13.8	7.5	34,500	↓	↓
		3.64	0.047	98.7	↓	↓	13.8	7.5	34,500	↓	↓
	11.22/77	4.39	0.053	98.8	↓	↓	14.7	8.5	33,000	↓	↓
		4.86	0.063	98.7	↓	↓	14.7	8.5	33,500	↓	↓
	11/23/77	5.00	0.051	99.0	↓	↓	6.0	3.0	18,000	↓	↓
		3.91	0.054	98.6	↓	↓	6.0	3.0	18,000	↓	↓
	11/25/77	4.08	0.053	98.7	↓	↓	6.0	3.0	18,000	↓	↓
		3.36	0.051	98.5	↓	↓	6.0	3.0	18,000	↓	↓

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(1) Excluding mist eliminator pressure drop.

Table M-1 (continued)

VENTURI/SPRAY TOWER PARTICULATE MASS LOADING TEST RESULTS

Run No.	Date	Inlet, gr/dscf	Outlet, gr/dscf	Removal, %	Alkali	Fly Ash Loading	Venturi P, in. H_2O	System P,(1) in. H_2O	Gas Rate, acfm @ 300° F	Slurry Rate, gpm		MgO Addition	Solids Recirculated, wt %
										V	ST		
819-1B	12/09/77	3.55	0.044	98.8	LS	HIGH	6.7	13.4	32,000	600	1600	NO	8.6-10.5
819-1B	12/09/77	3.55	0.038	98.9	LS	HIGH	6.8	13.1	32,000	600	1600	NO	8.6-10.5
863-1A	12/20/77	3.90	0.036	99.1	L	HIGH	6.3	11.2	29,000	600	1600	NO	8.9-11.9
863-1A	12/22/77	5.66	0.038	99.3	L	HIGH	7.8	14.4	34,000	600	1600	NO	8.9-11.9
863-1A	12/27/77	4.80	0.039	99.2	L	HIGH	8.6	15.3	35,000	600	1600	NO	8.9-11.9
863-1A	12/28/77	4.80	0.051	98.9	L	HIGH	8.5	13.8	33,000	600	1600	NO	8.9-11.9
863-1A	12/28/77	4.28	0.034	99.2	L	HIGH	8.3	15.0	35,000	600	1600	NO	8.9-11.9
863-1A	12/29/77	----	0.044	----	L	HIGH	8.5	14.8	35,000	600	1600	NO	8.9-11.9
863-1A	12/29/77	----	0.046	----	L	HIGH	8.5	15.8	35,000	600	1600	NO	8.9-11.9
863-1A	01/03/78	5.28	0.051	99.0	L	HIGH	8.2	15.1	30,000	600	1600	NO	8.9-11.9
863-1A	01/05/78	4.13	0.054	98.7	L	HIGH	8.2	15.3	35,000	600	1600	NO	8.9-11.9
863-1A	01/05/78	----	0.059	----	L	HIGH	7.8	14.9	35,000	600	1600	NO	8.9-11.9
863-1A	01/19/78	----	0.044	----	L	HIGH	5.2	9.5	29,000	600	1600	NO	8.9-11.9
863-1A	01/19/78	----	0.037	----	L	HIGH	6.5	10.3	28,000	600	1600	NO	8.9-11.9
863-1A	01/20/78	----	0.047	----	L	HIGH	7.0	12.2	30,000	600	1600	NO	8.9-11.9
864-1A	01/24/78	----	0.032	----	L	HIGH	7.5	15.2	35,000	600	1600	NO	9.1- 9.9
864-1A	01/24/78	5.37	0.035	99.3	L	HIGH	7.5	15.1	35,000	600	1600	NO	9.1- 9.9
866-1A	02/17/78	2.31	0.023	99.0	L	HIGH	9.1	16.7	35,000	600	1600	NO	8.7-11.1
822-1A	05/01/78	5.49	-----	----	LS	HIGH	7.7	15.2	31,000	600	1600	YES	6.6- 9.4
822-1A	05/02/78	4.58	-----	----	LS	HIGH	7.9	15.5	31,000	600	1600	YES	6.6- 9.4
822-1A	05/04/78	4.25	-----	----	LS	HIGH	7.9	14.5	30,000	600	1600	YES	6.6- 9.4

(1) Excluding mist eliminator pressure drop.

Table M-2

TCA PARTICULATE MASS LOADING TEST RESULTS

Run No.	Date	Inlet, gr/dscf	Outlet, gr/dscf	Removal, %	Alkali	Fly Ash	System ΔP,[1] in. H_2O	Gas Rate, acfm @ 300°F	Slurry Rate, gpm
708-2A	3/10/77	5.05	0.059	98.8	LS	Yes	7.9	30,000	1200
708-2A	3/14/77	5.03	0.048	99.0	LS	Yes	7.5	30,000	1200
709-2A	3/15/77	4.57	0.096	97.9	LS	Yes	5.8	30,000	1200
806-2A	7/29/77	--	0.048	--	LS	Yes	7.9	30,000	1200
806-2A	7/29/77	--	0.047	--	LS	Yes	7.9	30,000	1200
806-2A	8/ 1/77	--	0.044	--	LS	Yes	7.9	30,000	1200
806-2A	8/ 1/77	--	0.045	--	LS	Yes	7.9	30,000	1200
807-2A	8/ 3/77	--	0.040	--	LS	Yes	8.5	30,000	1200
807-2A	8/ 3/77	--	0.035	--	LS	Yes	8.5	30,000	1200
807-2A	8/ 4/77	4.39	0.033	99.2	LS	Yes	8.6	30,000	1200
807-2A	8/ 4/77	3.85	0.033	99.1	LS	Yes	8.6	30,000	1200
808-2A	8/15/77	--	0.058	--	LS	Yes	8.2	30,000	1200
808-2A	8/16/77	--	0.048	--	LS	Yes	8.4	30,000	1200
809-2A	8/18/77	--	0.059	--	LS	Yes	8.5	30,000	1200
809-2A	8/18/77	--	0.044	--	LS	Yes	8.5	30,000	1200
809-2A	8/22/77	--	0.067	--	LS	Yes	8.6	30,000	1200
810-2A	8/25/77	--	0.040	--	LS	Yes	8.6	30,000	1200
810-2A	8/25/77	--	0.040	--	LS	Yes	8.6	30,000	1200
810-2A	8/29/77	--	0.045	--	LS	Yes	8.5	30,000	1200
714-2A	9/ 2/77	--	0.027	--	LS	Yes	8.5	30,000	1200
714-2B	9/ 8/77	--	0.048	--	LS	Yes	5.7	30,000	1200
811-2A	9/12/77	--	0.035	--	LS	Yes	8.2	30,000	1200
811-2A	9/13/77	--	0.036	--	LS	Yes	8.3	30,000	1200
811-2A	9/14/77	--	0.038	--	LS	Yes	8.2	30,000	1200
811-2A	9/15/77	--	0.049	--	LS	Yes	8.2	30,000	1200

(1) Excluding mist eliminator pressure drop

Table M-2 (continued)

TCA PARTICULATE MASS LOADING TEST RESULTS

Run No.	Date	Inlet, gr/dscf	Outlet, gr/dscf	Removal, %	Alkali	Fly Ash	System ΔP,[1] in. H_2O	Gas Rate, acfm @ 300°F	Slurry Rate, gpm	Scrubber Internals
715-2A	10/11/77	--	0.033	--	LS	Yes	10.0 - 12.5	30,000	1000	3-beds, 4-grids 7-1/2 in. per bed
		--	0.032	--						
		4.89	--	--						
	10/12/77	3.65	0.034	99.1						
		4.10	0.034	99.2						
		4.21	0.060	98.6						
	10/13/77	3.64	0.038	99.0						
		3.74	0.041	98.9						
716-2A	10/15/77	--	0.026	--						
		--	0.032	--			12.8 - 16.1	27,000	1000	3-beds, 4 -grids, 10 in. per bed
		--	0.029	--						
		--	0.024	--						
		--	0.022	--						
	10/17/77	2.86	0.018	99.4						
		3.26	0.020	99.4						
	10/18/77	3.33	0.028	99.2						
		3.99	--	--						
	10/19/77	4.58	0.026	99.4						
717-2A	10/25/77	--	0.027	--						
		--	0.031	--			10.9	29,000	1000	3-bed, 4-grids, 7-1/2 in. per bed
	10/26/77	--	0.033	--			11.1	29,000		
	10/28/77	--	0.034	--			9.6	27,000		
	11/ 1/77	5.23	0.031	99.4			10.5	29,000		
		5.23	0.036	99.3			9.7	29,000		
	11/ 2/77	3.38	0.027	99.2			8.5	27,000		
		3.91	0.026	99.3			11.3	30,000		
	11/ 9/77	--	0.069	--			10.9	29,000		
		--	0.051	--			7.3	25,000		
	11/10/77	--	0.054	--			10.5	28,500		
		--	0.050	--			6.5	20,000		
	11/11/77	3.21	0.046	98.6			6.4	20,000		
		2.95	0.043	98.5			6.3	20,000		
	11/15/77	3.01	0.036	98.8			6.1	20,000		
		4.05	0.043	98.9			10.9	30,000		
	11/16/77	3.32	0.041	98.8			10.6	30,000		
		3.90	0.059	98.5			10.2	30,000		
	11/17/77	3.03	0.064	97.9			10.5	30,000		
		3.45	0.051	98.5			6.3	20,000		
	11/18/77	3.29	0.062	98.1			6.3	20,000		
		4.00	0.041	99.0			--	30,000		
718-2A	11/28/77	3.95	0.046	98.8			--	30,000		
		3.75	0.044	98.8			6.5 - 8.2	30,000	1200	Cellcote Support Plates[2]
	11/29/77	4.83	0.038	99.2						
		3.59	0.039	98.9						

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(1) Excluding mist eliminator pressure drop.

(2) 4-grids, 23 layers of Ceilcote support plates (46 in. total height) between 2nd and 3rd grids

Table M-2 (continued)
TCA PARTICULATE MASS LOADING TEST RESULTS

Run No.	Date	Inlet, gr/dscf	Outlet, gr/dscf	Removal, %	Alkali	Fly Ash Loading	System ΔP,(1) in. H_2O	Gas Rate, acfm @ 300° F	Slurry Rate gpm	MgO Addition	Solids Recirculated, wt %
719-2A	12/02/77	4.11	0.064	98.4	LS	HIGH	2.8	18,000	1200	NO	14.1-15.5
719-2A	12/02/77	----	0.059	----	LS	HIGH	2.8	18,000	1200	NO	14.1-15.5
719-2A	12/05/77	----	0.060	----	LS	HIGH	3.0	18,000	1200	NO	14.1-15.5
719-2A	12/05/77	3.28	0.064	98.0	LS	HIGH	3.2	18,000	1200	NO	14.1-15.5
719-2A	12/06/77	3.29	0.060	98.2	LS	HIGH	3.4	18,000	1200	NO	14.1-15.5
719-2A	12/06/77	3.27	0.056	98.3	LS	HIGH	3.9	18,500	1200	NO	14.1-15.5
719-2A	12/07/77	3.25	0.056	98.3	LS	HIGH	3.8	17,500	1200	NO	14.1-15.5
719-2A	12/07/77	3.67	0.065	98.2	LS	HIGH	3.6	17,500	1200	NO	14.1-15.5
719-2A	12/08/77	3.18	0.057	98.2	LS	HIGH	4.0	18,500	1200	NO	14.1-15.5
719-2A	12/08/77	4.25	0.055	98.7	LS	HIGH	3.5	18,000	1200	NO	14.1-15.5
815-2A	12/12/77	4.58	0.045	99.0	LS	HIGH	13.1	30,000	1000	NO	14.2-15.6
815-2A	12/12/77	4.01	0.059	98.5	LS	HIGH	13.0	30,000	1000	NO	14.2-15.6
815-2A	12/14/77	4.49	0.118	97.4	LS	HIGH	11.3	29,500	1000	NO	14.2-15.6
816-2A	12/16/77	4.57	0.031	99.3	LS	HIGH	11.9	28,000	1000	NO	14.7-15.7
817-2A	12/19/77	5.11	0.040	99.2	LS	HIGH	7.0	19,000	1000	NO	13.6-15.2
818-2B	01/04/78	4.76	0.036	99.2	LS	HIGH	8.0	25,000	1000	NO	13.8-14.8
818-2B	01/04/78	3.68	0.037	99.0	LS	HIGH	8.0	25,000	1000	NO	13.8-14.8
590-2A	01/25/78	4.72	0.082	98.3	LS	HIGH	10.6	30,000	1200	NO	13.2-14.5
618-2A	02/08/78	2.92	0.032	98.9	L	HIGH	12.9	30,000	1200	NO	6.5- 9.1
618-2A	02/09/78	3.73	0.029	99.2	L	HIGH	10.6	30,000	1200	NO	6.5- 9.1
618-2A	02/10/78	4.11	0.040	99.0	L	HIGH	10.6	30,000	1200	NO	6.5- 9.1
618-2A	02/14/78	2.95	0.031	98.9	L	HIGH	13.3	30,000	1200	NO	6.5- 9.1
618-2A	02/14/78	4.22	0.027	99.4	L	HIGH	12.0	30,000	1200	NO	6.5- 9.1
618-2A	02/15/78	3.65	0.035	99.0	L	HIGH	14.1	30,000	1200	NO	6.5- 9.1
618-2A	02/16/78	3.89	0.029	99.3	L	HIGH	12.3	30,000	1200	NO	6.5- 9.1
618-2A	02/16/78	3.89	0.029	99.3	L	HIGH	13.3	30,000	1200	NO	6.5- 9.1

(1) Excluding mist eliminator pressure drop.

Table M-2 (continued)

TCA PARTICULATE MASS LOADING TEST RESULTS

Run No.	Date	Inlet, gr/dscf	Outlet, gr/dscf	Removal, %	Alkali	Fly Ash Loading	System P,(1) in. H_2O	Gas Rate, acfm @ 300° F	Slurry Rate gpm	MgO Addition	Solids Recirculated, wt %
619-2A	02/21/78	3.15	0.043	98.6	L	HIGH	10.5	30,000	1200	YES	7.3- 8.8
619-2A	02/22/78	----	0.046	----	L	HIGH	11.0	30,000	1200	YES	7.3- 8.8
619-2A	02/22/78	----	0.046	----	L	HIGH	10.5	30,000	1200	YES	7.3- 8.8
619-2A	02/23/78	3.31	0.044	98.7	L	HIGH	8.4	30,000	1200	YES	7.3- 8.8
619-2A	02/23/78	2.23	0.047	97.9	L	HIGH	9.5	30,000	1200	YES	7.3- 8.8
619-2A	02/24/78	----	0.045	----	L	HIGH	7.0	30,000	1200	YES	7.3- 8.8
619-2A	02/24/78	----	0.038	----	L	HIGH	8.8	30,000	1200	YES	7.3- 8.8
621-2A	03/24/78	7.57	0.042	99.4	L	HIGH	9.4	30,000	1200	YES	7.3- 8.8
592-2A	04/19/78	4.69	0.055	98.8	L	HIGH	8.6	30,000	1200	YES	6.6- 9.6
622-2A	05/11/78	4.54	-----	----	LS	HIGH	7.2	30,000	1200	YES	14.3-15.7
622-2A	05/12/78	4.11	0.061	98.5	L	HIGH	6.8	30,000	900	YES	7.7- 9.5
622-2B	05/15/78	4.17	0.055	98.7	L	HIGH	6.9	30,000	900	YES	7.7- 9.5
622-2B	05/16/78	5.28	0.064	98.8	L	HIGH	6.4	30,000	900	YES	7.3- 8.7
622-2B	05/17/78	----	0.038	----	L	HIGH	6.4	30,000	900	YES	7.3- 8.7
623-2A	05/22/78	4.26	0.038	99.1	L	HIGH	7.5	30,000	900	YES	7.3- 8.7
623-2A	05/23/78	3.67	0.054	98.5	L	HIGH	6.9	30,000	1200	YES	7.4- 9.0
623-2A	05/26/78	4.16	0.052	98.8	L	HIGH	7.3	30,000	1200	YES	7.4- 9.0

(1) Excluding mist eliminator pressure drop.